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ENGLISH TELEPHONE PATENTS.

A LITTLE more than seven months ago Mr. Justice North intimated that his judgment in the telephone case, which had been before him then for several days, would be for the plaintiffs, that is to say, for the United Telephone Company against Mr. Bassano, whose telephone transmitter was alleged to be an infringement of that of Edison. Last Saturday, he delivered judgment formally, occupying more than three-quarters of an hour in reading rapidly the lengthy document which he had prepared. The reasoning had need to be elaborate and to require time, to reconcile the judgment with the facts of the case: and after wading through the six columns of the judgment, reprinted in another part of the REVIEW, we venture to assert that the majority of our readers will be far from convinced that Mr. Justice North has reconciled them. A valued correspondent draws particular attention in our other columns to some of the striking passages, a free version of which he presents. For ourselves, we have so often given our views on the matter and opened our columns for its discussion, that nothing remains but for us to say that we remain unshaken in our belief that Edison did not intend to make such an all-embracing claim as that which is now maintained for his specification, and that it is a reduction of argument to the point of absurdity to seriously advance the extraordinary statements with reference to a diaphragm which have now been legally justified.

WHAT IS A GUARANTEE?

IN another column will be found the report of a case which occupied the attention of the judge in the Lord Mayor's Court at the Guildhall on Friday last week. This case, Crossley *v.* Littleton, presents one or two curious features, and intending purchasers of Otto gas engines will find it interesting. Messrs. Crossley Brothers claimed for repairs executed on a gas engine, those repairs having become necessary within a month of the sale. Mr. Littleton urged in defence that he held a guarantee from the plaintiffs that they would put right all derangements occurring through ordinary usage during the first six months after they supplied the engine. But Messrs. Crossley disclaimed having sold the engine to Mr. Littleton at all. The latter alleged that he purchased from the plaintiffs, but through a third party whom he distinctly understood to be their agent, and who was sent to him by their manager. Upon this point, as to whether the third party, a Mr. Heath, was or was not an agent of the plaintiffs, which was really the main question at issue between the parties, there was direct conflict of evidence. Mr. Littleton was positive that Mr. Heath was represented to him as an agent for Messrs. Crossley Brothers, and the plaintiffs' manager was equally sure that he merely recommended him as a middle-man, or "a man in the trade," who was willing to negotiate the business at a low rate of commission, the difficulty in the way of a direct deal being that the defendant insisted upon being supplied upon trade terms, to which the plaintiffs' manager did not consider him entitled. This "man in the trade," according to the latter theory, was to purchase the engine at the usual trade discount price—15 per cent. off—and sell it again to Mr. Littleton at an advance of 2½ per cent., a rate of profit which any considerable "contractor" might be expected to disdain. It was expected that the case would be fought out upon this question, and witnesses were examined and cross-examined mainly with reference to it. But after all evidence had been called, and the counsel for the defendant was addressing the jury on behalf of his client, the judge suddenly discovered that the first question which the jury would have to decide was whether the repairs were such as would, supposing no dispute to exist as to the direct sale from the plaintiffs to the defendant, be covered by the terms of the guarantee. Interrupting Mr. Corrie Grant, defendant's counsel, he reminded the jury that a witness early in the case had stated that the repairs carried out were not such as were usually done under the guarantee, that the witness was not cross-examined on the point, and that the fact was therefore not really disputed. Mr. Corrie Grant was labouring under the difficulty of having been instructed but a few hours before the commencement of the case, and could only mention this in explanation of his omission to cross-examine upon the question of the guarantee. The plaintiffs' counsel seized upon the new point in his favour and made the most of it; and in the summing up which followed, the judge once more insisted at length on the importance of the new phase which he had himself given the case. It was for the jury to consider first, he told them, whether the repairs were covered by the terms of the guarantee; defendant had called no evidence to prove that they were, and had failed to cross-examine the witness who said they were not, and therefore—the inference was plain. If they found that the repairs were outside the guarantee, they must without further ado give a verdict for the plaintiff; but if they found that the work was what might reasonably have been done under the guarantee, then it would be for them to consider whether the plaintiff or the defendant was to be believed with reference to the part which Mr. Heath took in the transaction. After this positive kind of summing up, the jury did not require many minutes consultation before they, without answering specifically the two questions put to them, returned a verdict for the plaintiff for the whole amount. It may be assumed that it was upon the question of the guarantee that they justified their verdict; and this brings us to the motive of our remarks. Do manufacturers attach

any value to the guarantees which they give with their engines, or do they repudiate liability for all repairs after the engines have left their hands? In this case, the joints separating the cylinder from the water-jacket became imperfect after very little use, and allowed the water to percolate into the cylinder, with the result that the engine was soon brought to a standstill. Was not the repair needed here one which a guarantee might reasonably be held to cover? Intending customers of other manufacturing firms would do well, in face of the result of the case under notice, to have a clear and explicit understanding as to the real meaning and nature of the guarantee which are so readily given but so reluctantly acted upon.

DETERMINING THE COEFFICIENT OF SELF-INDUCTION.

Use of the Aperiodic Galvanometer, Deprez-d'Arsonval.—In a former communication, writes M. Ledebôer in *Comptes Rendus*, we have considered the case where there is in the external circuit of the Deprez-d'Arsonval galvanometer such a resistance that the movement may be aperiodic, but on the point of becoming periodic.

Under these conditions the aperiodic galvanometer may be substituted for the use of the periodic galvanometer; the only difference is the introduction, in the formula of the balistic galvanometer, of the factor e, the basis of the Napierian logarithms.

This may be done in particular for the determination of the coefficient of self-induction in Maxwell's method, as it has been applied by Lord Rayleigh.

The formula in question becomes under these conditions:

$$L = r \frac{T}{\pi} \frac{\delta}{a} e$$

The substitution of the aperiodic for the periodic galvanometer renders this matter very practical; for not only the former is unaffected by the presence of magnets, or even of powerful currents, but we avoid at the same time all the inconvenience due to the persistance of the movement of the galvanometer needle.

When the resistance of the coil whose coefficient of self-induction is being determined is weak, the above method has the inconvenience that the additional resistance, r, is very small. For certain coils which we have made use of the resistance was 0·2 ohm, and the additional resistance, r, was 0·0025 ohm to 0·0040 ohm. It is difficult to determine exactly the small resistances even if we use the double bridge method of Thomson.

In such cases it is more advantageous to apply the direct formula

$$L = \frac{T}{\pi} \frac{i}{a} e \frac{\delta}{I} \left[(R' + l' + g) \frac{R}{R'} + g \right]$$

in which $\frac{i}{a}$ is the constant of the galvanometer, the total resistance of which is g; R, R' l, l' the resistances of the four branches of the bridge; R that of the coil, the coefficient of self-induction of which is L, with $\frac{R}{R'} = \frac{l}{p}$, the galvanometer being interposed between R and R' on the one part, and between l and l' on the other.

We append here some measurements taken by the aid of these methods. We have measured the coefficient of self-induction of the two electro-magnets of identical forms, the one being wrapped with thick wire and the other with a finer wire; the same system of soft iron cores may be introduced into either of these systems of bobbins.

Electro-magnet with thick wire (resistance = 0·234 ohm).

	L without iron.	L with iron.
r = 0·0025 ohm. Thomson galvanometer ...	0·00084 × 10^9 *cm.*	0·0087 × 10^9 *cm.*
r = 0·0040 ohm. aperiodic galvanometer ...	0·00085 „	0·0088 „
Direct method	0·00077 „	0·0086 „

Electro-magnet with fine wire (resistance = 6·76 ohms).

	L without iron.	L with iron.
r = 0·05 ohm. Thomson galvanometer	0·021 × 10^9 *cm.*	0·22 × 10^9 *cm.*
r = 0·50 ohm. aperiodic galvanometer	0·023 „	0·23 „
Direct method	0·023 „	0·23 „

WESTON'S CURRENT AND ENERGY METERS.

IN 1824 Arago made his well-known experiment of causing a rapidly rotating disc of copper to induce a similar motion in a magnet placed above and parallel with it. He went so far even as to reverse the experiment, and effected the rotation of the disc by revolving the magnet. The explanation which he gave for this phenomenon was not satisfactory, and not until Faraday took up the subject was the true nature of the forces at work revealed. Faraday, however, went further than Arago, and recognising the fact that the motion produced was due to induced electric currents, proceeded in 1831 to produce a current generator, or magneto-electric machine, upon this principle. The apparatus took the form of a copper disc rotating between the poles of an electro-magnet, the current being taken off at the axis and at the circumference of the disc. Faraday at that time did not recognise the fact of the reversibility of the machine he had constructed; but in the light of our present knowledge it is evident that if a current be sent through the disc from an outer source, it will revolve, or in other words, become a motor.

It is upon the latter consideration, states the New York *Electrical World*, that Mr. Weston has constructed two very ingenious instruments, which, while analogous in principle, are used for different purposes of electrical measurement.

The principle upon which these instruments are based, viz., that of moving a conductor in a uniform field, is, in so far as its application to measuring instruments is concerned, original with Mr. Weston, who already in 1884 had constructed instruments on this principle, and from which the ones illustrated have been developed. Ferranti, in England, has constructed a meter in which this principle is employed, but, as stated above, Mr. Weston antedates him.

The first of these, the current meter, is shown in fig. 1 in perspective, fig. 2 being a section through the pole pieces. The instrument is essentially an electro-motor having a disc armature, but the motion of which is prevented by opposing springs. The field magnets employed are similar to those in machines with consequent poles, and the pole pieces are extended toward each other and brought close to the disc, A, as shown in fig. 2. The disc, as will be seen, is centred upon a copper rod, E, which passes through cores in the pole pieces and is supported at its upper end by a double-spiral spring, S, attached to the bracket, F. The lower end of the rod, E, is enlarged so as to form an inverted cup, which carries within it a cork, K. It dips into a trough of mercury, which forms an electrical connection for the copper rod, the cork acting as a float to relieve the spring of considerable weight. The outer edge of the disc, A, is bent downward, and dips into a circular trough of mercury, b, formed in the lower pole piece. A small screw, b', acts as a binding post; the lower mercury trough, L, mounted upon the base, being

also connected with a binding post, as shown in fig. 1. We must also add that the upper end of the screw carrying the springs is insulated from the bracket.

With this much by way of explanation, it becomes clear that a current led into the lower mercury trough

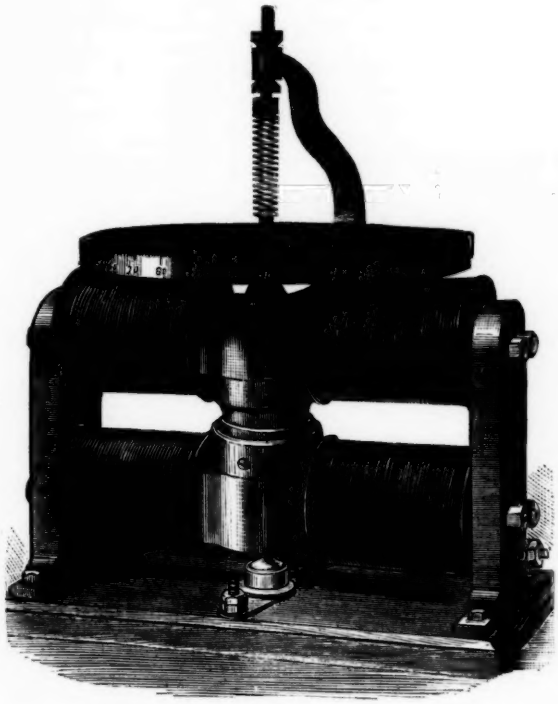

FIG. 1.—WESTON CURRENT METER.

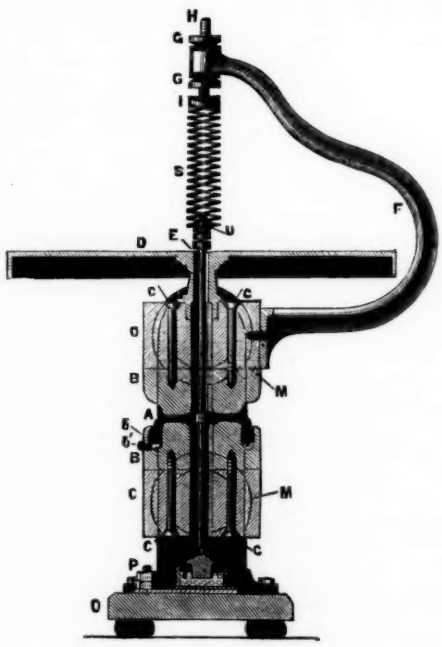

FIG. 2.—WESTON CURRENT METER—SECTION.

will pass up the rod, flow through the disc, and pass out through the upper mercury trough and binding screw. The disc being placed between powerful magnets, and having a current flowing through it, will naturally tend to revolve in accordance with the well-known law. Its motion is prevented, however, by the springs, which undergo a torsion proportional to the strength of the magnetic moment between the disc and armature. The stronger the current passing through the disc, the greater will be its tendency to revolve, and hence to distort the spring. The latter, as will be seen in fig. 1, has a pointer attached to it which passes over a graduated scale, and in this way the deflections of the spring are noted.

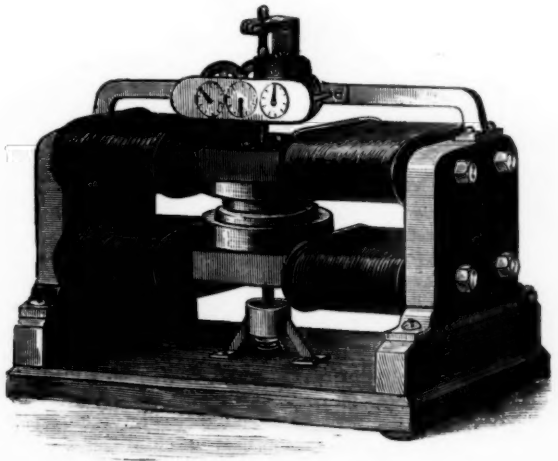

FIG. 3.—WESTON ENERGY METER.

While the instrument just described measures the current only, the one shown in fig. 3 measures continuously the energy passing through the circuit, or, in other words, the volt-ampères, and thus constitutes an electric meter. The principle upon which it is constructed is the same as that of the current meter, but instead of the motion of the disc being opposed by a spring, it is allowed free play and thus acts as a true motor. The spring, as will be seen, is replaced by a recording train upon which the number of revolutions are registered. The field magnets of high resistances are placed in independent circuit with the leads, and the strength of the magnets is thus proportional to the potential of the circuit. The full current, however, passes through the disc in the manner described above. Evidently the speed at which the disc revolves is proportional to the strength of the current in the disc and to the strength of the magnetic field. Thus the speed of the disc is a true measure of the energy in the circuit, indicating simultaneously the potential and current.

It is evident that the capacity of both instruments is practically unlimited, as the current which can be passed through them depends merely upon the size of the spindle and revolving disc. This is a great advantage, as it enables the instruments to be adapted for widely differing services and with equal accuracy.

Senegal Land Lines.—Recent news from this Colony shows the interruption of the landline which was lately completed, and which connects the French station of Bamakou, on the upper waters of the Niger, with the coast towns of Senegal. The section between Bakel and Matam is that which has suffered. Some time back we noted the energy and enterprise with which the construction of this line was being carried on by Monsieur Hubler, the chief of telegraphs for the colony of Senegal; who, without that military protection which has always been considered necessary (in the disturbed district between Bakel and Matam where the fighting is now going on), was successful in completing the last length, in a series of sections which unite the Upper Niger district with the coast, thus carrying telegraphic communication with Europe to a point which is over 700 miles inland, and which is only some 300 miles distant from Timbuctoo.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XV.

MOTORS which are destined for the propulsion of road vehicles require a different treatment from those which are to be used for driving fans, for instance, or boats. Where great inertia has to be overcome, as in the case of a car or a crane, then it is necessary to provide motors capable of exerting a large initial force, or statical pull. The starting of a tramcar demands an effort of considerable magnitude, whereas the setting in motion of a fan or a screw-propeller requires comparatively little force, air and water offering little resistance until a certain speed is attained. For the starting of a tramcar we have to consider not the *rate* of expenditure of energy, but merely the statical force, or the magnetic attraction between the armature and the field magnets of a motor.

To set a 5-ton car in motion on a level tramline we must provide a pull of at least 500 lbs. in the direction parallel to the motion of the vehicle; for starting the same up an incline of, say, 1 in 37—three times that initial force will be requisite. The motor, therefore, has to be constructed to give a statical force of from 500 to 2,000 lbs., according to the conditions of the road, and the ordinary laws of electro-magnets have in this case to be taken into consideration; we know that the magnetic moment of a given field magnet is proportional to the current strength, or with a given current to the number of turns in the magnetising coils. The armature of a series-motor receives the same current as the magnet, therefore the statical force of such a motor will vary as the square of the current strength; with 80 ampères flowing through a series-motor there would be a starting force of 6,400 arbitrary units. The value of each unit depends upon the size and construction of a machine, and it merely serves for the purpose of comparison. Now, if we wish to obtain a considerable effort with a reasonably low current, we have to provide a large number of turns of wire in the coils, and this involves, in a given space, appreciable resistances; and we have seen that the resistance of a car-motor must be comparatively high in order that excessive currents may be avoided at the instant of starting. Therefore, high-resistance motors are an advantage under these circumstances. In dynamos (generators) we carefully avoid internal resistances, for reasons well known to electricians.

Many arguments have been brought forward with reference to the superiority of drum armatures over ring armatures; the inner layers of copper wire of a Gramme armature, it has often been observed, are practically useless for the production of currents in a dynamo machine; but these inner layers of wire appear to contribute their share in magnetising the armature iron core, and thus assist materially in the production of the desired magnetic moment so useful with motors.

The author's experiments have shown that with the same amount of iron, copper, and the same current flowing, the statical effect due to Gramme (ring) winding is superior to that of Siemens's (drum) winding, and, again, the statical effect of the Paccinotti ring is very much greater than that of the Gramme ring, with the same amount of material and the same expenditure of energy.

The model constructed for this purpose consisted of an ordinary horseshoe shaped electro-magnet, with polepieces to receive the armature; the iron core of the armature was cut from a tube $3\frac{1}{2}$ inches in diameter, $3\frac{1}{2}$ inches long, and $\frac{1}{4}$ inch thickness of metal; diametrically opposite, and parallel to the axis, were two projections of strips of iron rivetted to the iron tube, $\frac{3}{16}$ inch thick, and 1 inch wide, extending to the ends of the tube. Four wire coils were wound upon this core, equal in depth to the iron teeth or projections, and the ends of the coils were joined in series to a four-part commutator. This formed a ring armature with two Paccinotti teeth, held to a spindle by two gunmetal brackets; upon one end of this spindle a V-grooved pulley was fastened, and a cord surrounding part of the groove served for suspending weights. The commutator was fixed to the spindle so that by turning the armature through 90° the teeth of the iron core were either in the neutral magnetic position, or they formed poles opposite to the field magnet poles as shown in figs. 13 and 14. Currents

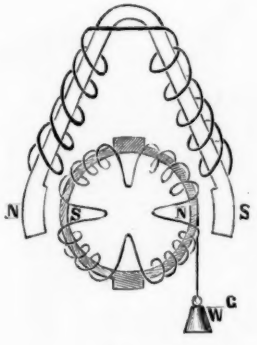

FIG. 13.

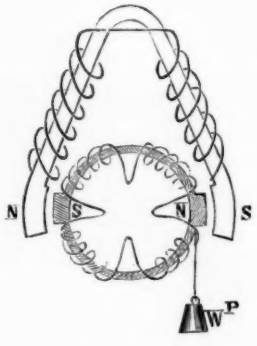

FIG. 14.

from a battery were sent through the magnet and armature, in series, and weights, W, suspended at the end of the cord, the weights were gradually increased until a balance between the magnetic pull and the gravitation pull was established; at this instant the armature, fig. 13, was turned through an angle of about 38° relatively to the field magnets, and armature, fig. 14, through about 26°; this angular deflection was the same at all currents. The following table gives the weights and corresponding currents for each, W^G referring to the Gramme and W^P to the Paccinotti arrangements:—

Current in ampères.	Weights in ounces.	
	W^G	W
1·21	17	60
2·7	26	200
4·1	36	288
6·82	54	407
8·14	60	444

These figures are instructive although not very conclusive, since this model does not represent the exact shape of either type of armature core, but the difference in the statical effect is very great, nearly as one to eight, owing to the proximity of the iron cores when projections are provided.

Dynamically, also, we find that the Paccinotti core offers advantages, as will be seen by reference to the researches and experiments made by Prof. Silvanus Thompson and recorded in his admirable treatise on "Dynamo-Electric Machinery." Mr. Esson's experiments on this subject are also exceedingly interesting, the results of which were embodied in two articles in the ELECTRICAL REVIEW, Vol. XVII.

Whether the Paccinotti armature core is really superior to the cores of the Gramme or Siemens generators is still a moot point with certain makers, but the mechanical advantages of this type of armature core for tramcar motors are very considerable; it is far superior weight for weight, and with equal expenditure of energy when used in motors which have to give

a great statical effect, and the projections are moreover very useful for holding and protecting the wire coils of the armature.

With regard to the general principles of construction the same rules hold good for motors as for dynamos. Wrought iron will be preferred to cast iron for magnets, since the latter metal has a much smaller magnetic capacity, and therefore a greater volume or weight of iron and copper is necessary to give the same effect. All the precautions as regards avoiding Foucault currents must be taken in motors as in dynamos.

Shunt motors are not suitable for tramcar propulsion, because in starting and mounting inclines the armature alone will get the excess of current, the field being constant.

Series motors give all the advantages for mounting gradients and for starting, but they race on the level or down slight slopes.

Compound wound motors combine the advantages of both the series and the shunt machine; but when considerable variations in speed and power are desirable, then we have to provide greater margins than the ordinary compound winding offers, if we wish to avoid the use of wasteful artificial resistances.

DOMESTIC ELECTRIC LIGHTING.*

By W. H. PREECE, F.R.S.

Electric lighting, on some distributive plan like that of gas, is still an event of the future in England. Other countries (notably the United States), Germany, Austria, Italy, Belgium, &c., are ahead of us, but in the electrical illumination of our houses we are in advance of all other countries. The number of private residences now lighted by electricity is very considerable.

I want to chronicle what has been done, and how it has been done. The pioneers of domestic electric lighting in England have been Sir William Thomson, Sir William Armstrong, Mr. Coope, Mr. Sellon, and Mr. Charles Moseley. Sir William Thomson used a gas engine, and worked his lamps direct from the dynamo, not only lighting his house, but his class-room and laboratory in the University of Glasgow; Sir William Armstrong obtained his power from a waterfall in his grounds; Mr. Coope used a steam engine; and Mr. Sellon and Mr. Moseley relied on secondary batteries, obtaining their power from a gas engine. Their good example has been very largely followed, and there are now a great many private houses in all parts of the country thoroughly and efficiently lighted.

Electric lighting means the utilisation for illuminating purposes of a certain amount of energy, which has to pass through various stages and forms, from its dormant condition in coal and water to its active condition in a lamp. I propose to discuss the question in each stage.

The Motor.

Steam, gas, and water have been used as agents for the production of power, but petroleum has not yet had a trial in England, and wind is too uncertain to be relied upon. Water is the most economical when it has not to be paid for, gas the most convenient, but steam is the most reliable.

A simple, effective, safe domestic steam motor has yet to be introduced. Hathorn, Davey and Co., of Leeds, exhibited at the Inventions Exhibition the best that has yet been made, but it has the disadvantage of requiring a large supply of water to condense the steam. It is a vacuum-engine working at atmospheric pressure, and is, therefore, free from explosion. A simple single or double acting steam-engine of small horse-power, that shall be economical in working and not liable to break down, easy of repair, that shall work with great regularity of speed, and be easily governed, and that does not require a skilled engineer to attend to it, is a great desideratum. The Council of the Society of Arts has under consideration a plan, so eminently successful in the agricultural world, and pursued for many years by the Royal Agricultural Society, of offering prizes for the best engines designed to fill the special purpose of providing power for electric lighting purposes. The points of merit that are considered to be of the greatest importance are—

a. Regulation of speed.

b. Power of automatically varying speed to suit variation of load.

c. Noiselessness.

d. Cheapness.

* Abstract of paper read before the Society of Arts, March 24th 1886.

The competition is intended to embrace all classes of engines—steam, gas, petroleum, &c.

The gas-engine seems best adapted to supply this want. Gas is already in use in most establishments within reach of gas works, and it seems far more natural to utilise the energy stored up in gas to generate power than to poison the atmosphere we breathe, deteriorate our valuables, and dirty our walls by burning it in air for illuminating purposes, especially as we get more light by doing so. Twenty-five cubic feet of gas will give us 1 horse-power, or eight 20 candle-power glow lamps, or 160 candle-power in all; but five 5-feet burners will give only 75 candles when burnt in air in ordinary burners. Gas-engines are within the intelligence of butlers, gardeners, and coachmen; they are always ready for work; they attain their maximum efficiency at once; they can be stopped in a moment. In spite of an oppressive monopoly nearly as bad as that of the telephone, they are rapidly coming into favour, and when the present patent expires, they will doubtless receive very great improvement, and much greater development.

In England the opportunities of using water-power are few and far between; in Scotland, however, the case is different. There several persons have utilised the water stored up in lakes. Sir John Fowler has lighted his Highland home by using three turbines of 12 horse-power, which, night and day, work dynamos. A 5-inch pipe from an artificial lake gives a head of 310 feet.

The Dynamo.

The relief which the practical world receives from the removal of the burden of a monopoly is well illustrated by the advances made in dynamos. The expiration of the Gramme patent was the signal for energy everywhere. Not only has the construction of the instrument been vastly improved mechanically, but its output has been trebled, and its price reduced to one-third; so that the dynamos of to-day are nine times better than they were during the existence of the patent. We are chiefly indebted to Elwell and Parker, of Wolverhampton, for leading the way. Hefner Alteneck first struck out a new path, which was taken up by Edison, and indeed has been well-nigh perfected by the high scientific attainments of Dr. J. Hopkinson, and has been ably followed by Mr. Crompton. Science has converted a crude instrument into the most perfect converter of energy that exists. Commercial enterprise has brought it within the reach of all. I have for the past two years been converting 2 horse-power into electrical energy with an Elwell-Parker dynamo that cost £30.

The improvements that have been effected are due chiefly to the more intimate knowledge that experience and study have given us of the theory of the machine. Better shaped magnets, more intense fields, more accurate proportion of parts, better copper and better iron, improved ventilation, have trebled the energy given out by each pound of copper wound on the armature. The intensity of the field has been increased five times; machines are far less troublesome; faults have become less frequent; armatures do not burst up so often; sparking at the brushes is less evident; commutators do not cut so much; heating of the coils is a thing of the past; and the ill-effects of self-induction are being eliminated.

The efficiency of a dynamo is the ratio of the energy given out in the external circuit to the energy supplied by the engine, and this in most modern dynamos exceeds 80 per cent. The out-put of a dynamo is measured by the number of watts it delivers, and this becomes a very convenient measure and indication of its capacity. Dynamos are now indicated in kilowatts (or "units," as some call them), and when we are told that such and such a dynamo is a 12-unit or a 12-kilowatt dynamo, we know it can deliver—

120 ampères at 100 volts, or
150 ampères at 80 volts, or
200 ampéres at 60 volts,

according to its requirements. This also enables us at once to determine the horse-power required to drive the dynamo. 12 kilowatts means 16 horse-power, add one-fourth to allow for loss and waste, and we get 20 horse-power. Dynamos usually indicate the E.M.F. they work at when driven at a certain speed, and they have, or ought to have, the proper number of revolutions per minute engraved or painted upon them. If makers would only supply with their dynamos their characteristic diagrams we should have all the information the user wants.

Dynamos are classified into *shunt*, *series*, or *compound* wound, according to the work they have to do. The former are almost exclusively used for domestic purposes, for reasons which will presently appear. A well-constructed dynamo, kept clean and well lubricated, never overworked, should last a lifetime without much attention except to the brushes and commutator.

Batteries.

No isolated installation is complete without a secondary battery. It maintains regularity and uniformity of current, so as to secure absolutely steady light; it supplies a reserve of power that renders one free from accident to engine or dynamo; it supplies a store of electricity that provides the householder with a source of light at all times and seasons. Its early failures disappointed many; it was launched before the public at too early a stage of its infancy, but it is now a matured, sober, practical instrument. Sir William Thomson says:—

"My cells have worked to perfection. It is the greatest possible comfort to us in the house to have the light with satis-

factorily equal brilliancy, at all hours of night and day, and every day in the week. I have now cut off the gas at the meter, so that there is absolutely none used in the house. I have no oil lamps, and have not used so much as a single quarter of a candle within the last three months, and have the electric light in every part of the house where light can possibly be wanted by night or by day."

I can confirm every word of this. I have now had nearly two years' experience of them, and I would just as soon dispense with them as I would with my fireplaces or bedclothes.

Originally I used them as a regulator to my gas engine, but I speedily found that it was more convenient and economical to charge them during the day, and discharge them through the lamps at night. In the depth of winter I charge them every day; in late autumn and early spring three times a week; and in summer I charge only once a week. It is very easy to know when the cells are fully charged. When the charging current is put on, the E.M.F. commences at about 2 volts per cell, and gradually rises to about 2·5 per cell. It acquires its maximum only when the cells are full. The current, on the contrary, falls. The density of the liquid, which is observed by a hydrometer floating in a cell, gradually rises, and when it becomes constant, the cell is full. Several hydrometers are used. Gas is then freely given off, and the cell has a milky appearance.

On the other hand, when a cell discharges the hydrometer sinks, and when it reaches a minimum point it must be charged again. The E.M.F. also commences to fall when it is too empty, but I never allow that point to be reached. Good cells give an efficiency of 70 per cent. without losing E.M.F., and with a loss of 10 per cent. they will give over 80 per cent. The useful rate of a battery is the number of ampère-hours it will give before losing 10 per cent. of its E.M.F. It is quite possible to get out of a battery all, or nearly all, the energy that we put in, but we cannot do so at a useful or economical rate. I give in the appendix a record of the charge and the discharge in my house in the month of February last, and also a record of last week's work.

The durability of these cells is most satisfactory. I see no reason why they should not last ten years at least. In fact, I believe the makers will maintain them at the rate of 10 per cent. per annum.

The faults that I have experienced are very few and rare. Short circuiting from peeling or buckling are things of the past. I have never seen a case of "treeing." Occasionally the connections develop resistance, and get hot, but this is solely due to neglect; they require attention and cleanliness.

It sometimes happens on high days or holidays that more current is wanted than can advisably be drawn from the cells; the engine is then allowed to run as well, but if the current developed by the dynamo is in excess of that used in the house, a few cells have to be taken off the battery, which is readily done by a switch, in order to maintain the E.M.F. in the house at its normal point. It is impossible, in fact, in the house to tell whether the engine is going or not. If it happens that the engine is kept continuously running, while the batteries are in action, special steps have then to be taken to prevent the cells from being irregularly charged, by changing the idle cells periodically.

A secondary battery acts perfectly as a regulator as long as it is well charged; its resistance is so small compared with the lamp circuit that it may be regarded as nothing, but if from any bad contact, fault, or weak cells, the resistance becomes appreciable, fluctuation in the light becomes evident, and it ceases to act efficiently.

The latest form of cells are exhibited on the table, and they are now so well-known that they need no description in this paper.*

PRIMARY BATTERIES.

I have had no practical experience of their employment for domestic lighting, nor have I seen a house lighted up by them; but I believe there are several installations at work, and I am sure the Society will be glad to hear in the discussion some facts from those present.

LAMPS.

No great progress can be chronicled in lamps like that in dynamos and secondary batteries. Their price remains very high. A good standard glow lamp has not yet been devised. I should like to see a 10-candle lamp working under a pressure of 50 volts, and requiring half an ampère, that would mean the absorption of 25 watts, or 2½ watts per candle. Its life would not be very great at present, but if it were cheap enough, one would not mind frequent renewals.

There is great variety of practice in determining the number of volts best adapted to work an installation. The conditions that regulate a central station system are quite different from those regulating domestic lighting. The former requires high pressure to reduce the weight of the mains, the latter requires low pressure to reduce the number of cells. Both are governed by economical reasons. I recommend 50 volts for home lighting. I tried originally 31 volts, but I had to increase the pressure, for the low volt lamps took too much current from my cells.

Makers of lamps seem to consider that there is great credit in securing long life. Unfortunately, glow lamps deteriorate sadly with age. The carbon wastes inperceptibly away, and we are scarcely conscious of the fact that, after 200 or 300 hours, the lamp gives only half the light it did at first. The fact is lamps last too long. I have been relegating my old lamps to the bedrooms, but they will not die, and I have been obliged to remove them "ere their time." The price of a lamp should be such that we could afford to give them a short and merry life. Long life is therefore an objection.

The efficiency of a lamp is generally taken to be the number of watts it consumes per candle per 1,000 hours of life; but a good measure of efficiency would be the number of hours it took to lose 10 per cent. of its normal light when absorbing 2½ watts per candle.

Some interesting experiments were recently made in Berlin on this point by Mr. Wilhelm Siemens, who showed that in 800 hours an unflashed carbon, consuming 5 watts per candle, lost 37·7 per cent. of its light, falling from 19·9 candles to 11; while a flashed carbon, consuming 3·2 watts per candle, lost only 12·7 per cent., falling from 17·5 candles to 14·5. The resistance of the former increased 12·7 per cent., of the latter only 4·2 per cent. The process of flashing carbon is a process by which pure hard grey carbon is deposited upon the carbon filament by heat, decomposing some hydrocarbon gas with which the globe is filled. This deposit of carbon enables the filament to acquire a brighter surface, and attain a higher temperature before commencing to disintegrate, and therefore it gives a higher efficiency, for the amount of light given out depends simply upon the temperature.

A glow lamp, when incandesced, seems to lose its carbon mass steadily and regularly. The carbon molecules fly off, and are projected against the sides of the globe, where they adhere, and cloud or discolour the glass, so that the light is diminished in two ways—first, by the wasting of the carbon, and, secondly, by its being deposited upon the glass, and preventing its radiation. The resistance increases owing to the diminution of the sectional area. This goes on until eventually, at some weak point, the mechanical strength is reduced to such a point that the filament becomes too weak to bear the slight strain upon it, and it breaks; or the density of the current becomes too high, and it dissipates away like a bright star, leaving a gap across the filament. This weak spot can often be detected by its brilliance before the lamp goes.

There is a critical point in all lamps when a change of state occurs in the carbon filament. It is shown by the appearance of a beautiful blue effect pervading the whole globe. It occurs at some point between 1 and 2 watts per candle. It should be determined for each kind of lamp.

I have an example of a lamp destroyed by lightning in Mr. Elwell's house, near Wolverhampton, which shows very beautifully the destructive effect on carbon of very high E.M.F. The globe is converted into a beautiful mirror.

Lamps fail in giving their light occasionally from having an imperfect vacuum. This is very easily detected by feeling the globe. If the vacuum is bad it gets quite hot. Mr. J. T. Bottomley showed that a wire became red hot when the air was exhausted from the globe, though it was only 80° C. when the air was in. Occasionally, but very rarely, lamps explode with a loud report when the current is first put on. This is, perhaps, due to a slight leakage of air making an explosive mixture with the residual gas.

At the present moment, both the nomenclature and the efficiency of glow lamps are in a very unsatisfactory state, and we are buying pigs in a poke at a very high price.

Mr. Edison adopted the very meritorious plan of determining the E.M.F. which would give his lamps a life of 1,000 hours, and the current that would give it the normal light. If this were done by every maker, it would be easy to determine the life at any other E.M.F., or the light at any other current, for the former varies with the twenty-fifth power of the E.M.F., and the latter with the sixth power of the current.

Considerable difference of opinion exists as to the character of the globe enveloping the carbon filament. Some like them clear, some like them ground; others envelope them in shades—generating light simply to choke it; while others, at a great loss, make the globe of a beautiful opal glass. It is very objectionable to have the optic nerve irritated by a brilliant glowing filament; but it is equally absurd to produce a good thing and then strangle it. Grounding and shading mean loss of light. Lamps can be placed so high that they need not affect the eye, and if they do, the light can be so reflected as to be useful elsewhere. The art of lighting a room is to flood it with light without the delicate eye being offended with the direct rays from the source of light.

An essential feature of a good lamp is a good holder, by which lamps can be readily removed and renewed. Mr. Alfred Swan has recently introduced a "vitrite" holder which leaves little to be desired.

Cuts-out or safety valves are essential to the security of a house. They should be fixed on every circuit.

FITTINGS.

The comfort and pleasure of a house depends upon its fittings. It is here that taste has its sway and art its swing, and the two are regulated only by the balance at the bank. Sir David Salomons, who has spared no expense in obtaining energy at Broomhill, has exercised wise economy and rare taste in fixing his lamps. They are so suspended by their own conductors that in daylight you do not see them, but when darkness comes they spring into light like beautiful stars floating in the air. No one has taught us so much in this direction as Mr. Tayler-Smith, whose portable lamps and useful appliances were so much ad-

* Until January of this year I had been using Elwell-Parker cells at my house, but I am now trying the E.P.S. form, having removed the former to the Post Office.

mired at the Healtheries and at the Inventions last year. My house is full of them. I have lamps everywhere, and I can get light wherever and whenever I want it.

WIRING.

No one must imagine that electric lighting is absolutely safe from fire. It is very simple to secure safety if the rules and regulations to avoid fire risks be carefully followed. The simplest rule is to use nothing but the best insulated wire, and to employ none but experienced men to put it up. All accidents that have occurred have arisen from careless wiring and ignorant handling.

In a new and growing business like electric lighting, competition should be very guardedly resorted to. There are firms of repute who are experts, and who can be trusted to carry out everything, but they are few. Protection should be procured by careful specification and constant supervision. The electrical engineer is as essential to the success of the building as the architect, and he should be engaged professionally. There is a great deal too much work done by the tradesman alone, and too little left to the expert. The design of the circuits of a house, the dimensions of conductors, the quality of the materials used, the provisions against fire risks, the testing of the work done, the adaptability of means to an end, should come within the province of the professional adviser, and not be left to the successful competing contractor, however eminent the firm may be.

METERS.

The most efficient, reliable, and simple voltmeter that I know is Cardew's, and Siemens's electro-dynamometer remains master of the situation.

Ferranti's meter is a most admirable adjunct. In my house one measures the current going into the batteries, and another measures the current coming out, so that I am able to keep an accurate debtor and creditor account against my battery. The result for February is seen in the appendix. How far these meters are accurate within a wide range has yet to be determined. They are certainly more accurate than gas meters, and they are more easily comprehended.

When electricity is laid on a house it can be used for other purposes besides illumination. Mr. Sellon uses it for heating: a current of fresh warmed air passes through a coil at a temperature of about 180° Fahr. and warms water-closets and dressing-rooms.

I am now trying charming little portable lamps, worked by secondary cells, made by Mr. Pitkin, which enables me to visit my cellars with comfort.

TESTING.

It is most desirable that every means should be adopted in a house to test the condition of the wires and apparatus constantly. Any incipient fault in a wire would speedily develop into a serious trouble under the influence of such powerful currents as electric lighting requires. It is therefore essential to detect its existence at once.

It is often said that it is all very well for me—an expert—to rejoice over the success of electric lighting in my own house. It would be a disgrace if it were not so, but there are non-experts who have been equally successful. As regards cost, it comes out just twice that of gas; for, though I burn no more gas than I burnt before, I have more wages to pay; there are also repairs to machinery, and the purchase of oil and waste. The lighting of my home cost me, in 1885, £60 0s. 6d.

Gas	£34	9	0
Oil	2	5	0
Waste	0	12	0
Brushes	0	17	0
Repairs	4	9	6
Wages	10	8	0
Lamps	7	10	0
	£60	0	6

Now, if we charge against this the value of steady light, pure air, no heat, absence of matches, candles and oil, comfort, durability of pictures, decorations and books, no painters, cleanliness, cheerfulness, health, gain of time, long life, there is little doubt on which side the balance will appear.

APPENDIX.

TABLE I.—E.P.S. CELLS AT GOTHIC LODGE DURING MONTH OF FEBRUARY.

Date.	E.M.F.	Ampère hours. Put in.	Ampère hours. Taken out.	Remarks.
1	50·7	121	55	
2	51·8	64	46	
3	51·8	72	44	
4	52·8	72	38	25 cells, 15 L type.
5	51·8	81	50	
6	52·0	91	53	
7	52·2	—	41	Internal resistance 0·0015″ per cell.
8	52·2	140	44	
9	52·3	—	50	
10	52·2	110	47	
11	51·8	—	50	Total put in, 1,747 ampère hours.
12	51·8	92	30	
13	52·0	102	37	
14	52·0	—	44	Total taken out, 1,251 ampère hours
15	52·0	123	44	
16	52·0	—	55	
17	52·0	116	47	
18	51·8	—	40	Efficiency 72 per cent.
19	52·0	102	47	
20	52·0	61	53	
21	52·0	—	42	Average hours of lighting—5.
22	52·0	118	34	
23	52·0	—	44	
24	52·0	110	44	Average number of lamps burning—12.
25	52·0	—	45	
26	52·0	115	45	
27	52·0	57	41	
28	52·0	—	41	

TABLE II.—CHARGING BATTERIES.

Date.	Hour.	E.M.F.	Current.	Hydrometer readings on cells. No. 2.	No. 5.	No. 14.	No. 17.	No. 20.	No. 25.	Remarks
	h. m.	volts.	ampères.							*March 18th.*
March 18th	8 0	57	16	1,160	1,165	1,150	1,150	1,150	1,150	Reading by meter 2,895,580
	9 0	57	18	1,160	1,165	1,150	1,150	1,150	1,150	Previous reading 2,801,650
	11 0	59	19	1,165	1,170	1,155	1,155	1,155	1,150	93,930
	12 0	60	19	1,170	1,175	1,160	1,160	1,160	1,155	
	1 0	62	19	1,175	1,180	1,165	1,165	1,165	1,165	Constant of meter, 630.
	2 0	67	19	1,175	1,180	1,170	1,170	1,165	1,165	9,930 ÷ 630 = 149 ampère hours put into batteries.
	3 0	68	17	1,175	1,180	1,170	1,170	1,165	1,170	
	4 0	69	16	1,175	1,180	1,170	1,170	1,165	1,170	Average charging currrent = 19″
„ 19th	...	...	...	1,170	1,175	1,165	1,165	1,160	1,160	
										March 20th.
„ 20th	8 0	56	16	1,165	1,170	1,155	1,155	1,155	1,150	Reading by meter 2,957,760
	9 0	57	18	1,165	1,170	1,160	1,155	1,155	1,150	Previous reading 2,895,580
	10 0	59	20	1,170	1,175	1,165	1,160	1,160	1,155	
	11 0	62	20	1,170	1,175	1,165	1,165	1,160	1,155	62,180 ÷ 630 = 98 ampère hours put in. 62,180
	12 0	67	19	1,175	1,180	1,170	1,170	1,166	1,160	
	1 0	69	16	1,175	1,180	1,170	1,170	1,165	1,165	Average charging current = 19·6″
„ 21st	...	...	...	1,170	1,175	1,165	1,160	1,160	1,155	Discharge, 8·5 ampères per degree.
„ 22nd	...	...	...	1,165	1,170	1,160	1,155	1,155	1,150	

DISCUSSION.

The CHAIRMAN said he thought on a former occasion Mr. Preece had scarcely been so enthusiastic in favour of electric lighting as he had been that evening. He had spoken from his own experience, and shown that electric lighting had now come within the reach of a great number of people, if not of all; and he felt convinced that the public would no longer submit patiently to the restrictions which had up to the present stood in the way of this new industry. The underground miner was very much troubled for want of light, and it had been lately his duty to inquire into this

matter. Mr. Preece told them he had only now to take a large pocket battery into the mine, and when it was getting exhausted turn out the fluid, and fill it up again from a flask out of another pocket. In this respect he thought Mr. Preece had drawn rather a highly-coloured picture; but he would not discourage either him or the miner, in the hope that Mr. Pitkin, Mr. Blumberg, Mr. Skrivanoff, and others, would one day furnish an electric light which would do everything which was required in mining.

Sir FREDERICK BRAMWELL, F.R.S., said he could not accept Mr. Preece's ideas on political economy and some other matters, quite so readily as he did his views on electric lighting. He complained that the term horse-power was unphilosophical and illogical, but he did not say why it was so; except that it was 746 times something else which was philosophical and logical. He could not help feeling that this was a paper for the upper classes, for gentlemen living in convenient detached houses, with gardens and gardeners, and such persons, no doubt, could indulge in the electric light; but he was one of the unfortunate people who had to live in London where they could, in a house in a row, and he wanted to know why he was to be debarred the use of the electric light. One thing which horrified Mr. Preece was monopoly. But if a man invented something which had never been known before, after years of trouble and large expenditure, why should he not be protected? Mr. Preece was a Government official, and until the year 1882 the Government were not amenable to royalty, but could take any man's patented invention, and use it without payment. By the Act of 1882, however, the Government had no longer that power, and he could not help thinking that this might partly account for Mr. Preece's hostility to patent monopolies. He said he wished someone would invent a lamp which would do so and so—but why should a man invent, if he were not to get anything out of his invention? If such a lamp were brought out, and the inventor were getting something out of it, Mr. Preece would at once be down upon him, and say it was an obnoxious monopoly.

Sir RICHARD WEBSTER, Q.C., M.P., said there was one point on which he should like some information, and that was the cost of installation, because this was a most important consideration, both from the point of view of those who could establish private installations of their own, and also from the public point of view, where electricity was to be supplied to a large number of houses. For example £7 10s. for lamps seemed a large sum; very possibly Mr. Preece in his good nature had been experimenting for the benefit of mankind, and had had a great many breakages, but £7 10s., at 5s. per lamp, would give 30; he had 58 lamps in his house, from 12 to 15 being used nightly, on an average, and perhaps 20 to 30 on special occasions, and he certainly had not broken six in two years. Apart from the cost of installation, he believed that when a gas-engine was used in a house where there was an intelligent man servant who could attend to it, the actual running of the electric light would not cost more than gas. He was satisfied that he did not spend more now than he used to spend on gas, oil and candles. The most interesting portion of the paper, from the public point of view, was no doubt the question of the extension of electric lighting to those who were not able to have their own installation in the way which had been described. The great reason why there was so much hesitation among people of moderate means to adopt electric lighting was because they had already paid a considerable sum for gas pipes and fittings, which would be thrown away. Now, since the passing of the Electric Lighting Act, there had been thousands of houses built, many in squares and large clusters, to all of which electric lighting might, and to many undoubtedly would, have been applied but for the absurd restrictions which had been referred to. He did not suppose one in a hundred had even been wired for electric lighting, though it might have been done easily and cheaply, so that all in a square or gardens might have been supplied from a central station. One thing they desired to do was to cheapen the cost of installation; that the money which was now expended in gas fittings should be devoted to wires, &c., which could be done much more economically in a new house than afterwards. If £500 or £700 were spent in fitting up one house, a hundred or two more would enable two or three to be supplied from the same source. The result would be that electric lighting could be supplied from a central station at very little more than the cost of gas. In a few years it might be quite as cheap, and then the only difference would be the cost of the wires and lamps in the first instance as compared with gas fittings. He hoped the present meeting and the public generally would strengthen the hands of the society in supporting Lord Rayleigh's Bill, and that such pressure would be brought to bear on the Government of the day as would lead to the removal of those restrictions which had hitherto stood in the way, and that then electric lighting might be brought within the reach, not of the rich only, but of those who were quite as deserving, and who had not the same facilities at their command.

Mr. CROMPTON said it was very difficult to state the cost of installation, as it depended so much on varying conditions. For instance, he had to estimate for lighting such a building as Hampton Court Palace, where the wires alone would cost about £3 per light, and on other occasions for mills and factories where the same item would be as low as 4s., so that it was almost impossible to give anything like an average. One reason why the lighting was so costly at present, was that the industry was such a small one; there were not men qualified to do the work in every town, as there were gasfitters; and in the case of a house like Sir John Fowler's, in the far north, he had to send almost to the other end of England, not only for the workmen, but for those who superintended the work, so that on a job of moderate size, the expenditure for wages was very heavy. He could also agree with Sir R. Webster that the cost mentioned by Mr. Preece seemed excessive; he seemed to have spent as much on gas in one year, with a 2 horse-power engine, as he (Mr. Crompton) did in two years with a 3½ horse-power. He had 68 lights, of which from 20 to 25 were usually in use, and his cost per annum for gas was only £15. His experience with lamps was also the same. No doubt if you made experiments you might break a great many lamps. He was supplied with enough lamps to keep his place going, even supposing they lasted the short time experimental lamps usually did; but he found that if he used the lamps originally invented by Mr. Swan, which still held a high position, a breakage of 5 per annum was the maximum. With regard to house to house lighting, which was no doubt the most important point, it was quite true that the Electric Lighting Act had had much to do with keeping back this industry. But it was only fair to say that it was only within the last six months that they had at command such appliances as would have enabled them to carry out general lighting at all. If it had not been for the excellent meter of Mr. Ferranti, there would have been no means of measuring the supply in any trustworthy manner, and any attempt to supply the light, apart from a meter, would have led to insufferable difficulties. Having tested the Ferranti meter very carefully, he had come to the conclusion that it was quite good enough for present purposes, and its perfection had removed one great stumbling block out of the path of co-operative electric lighting.

Mr. SELLON remarked that the interest in this subject was evidenced by the crowded state of the room. He first introduced electric lighting into his house in 1881, and ran about 110 lights, the average number used per night being about 50. These were all kept going by secondary batteries, the gas engine of 3½ horse-power being run a few hours per day. The cost per lamp per hour was ¾d., which would bear out Mr. Preece's statement of electricity being twice the cost of gas; but there were far greater considerations than the mere cost. Since 1881, he had never had to expend anything on paint, whitewashing or decoration, and this formed a substantial item on the credit side. Much scepticism had been expressed as to the life of secondary batteries, and of course there were good and bad batteries—good and bad manufacture, and good and bad treatment; but with a well-made apparatus, treated with ordinary care, the difficulties disappeared. He could show batteries made four years ago which were still in perfect working order, and to the inexperienced eye they looked as good as on the day they were put down; the experienced eye would perhaps detect a depreciation of about 10 per cent., but this was not much on apparatus of such a class.

Sir DAVID SALOMONS, Bart., said he had no connection with any one engaged in electric lighting, and he spoke entirely as one of the general public. He thought Mr. Preece's estimate of cost was extremely small, because he had included nothing for depreciation; the installation would cost £600 or £700, and on that 10 per cent., or 7½ per cent. at the least, ought to be charged. He used electricity on a large scale, employing on an average about 100 lights for 230 or 240 days in the year, and the expenditure did not exceed, with a sinking fund, £200 without interest, or £230 with it, and he considered that extremely low as compared with £60 without a sinking fund, or any other allowance. He went on to describe a method by which he could detect with certainty whether any lamps were alight after a proper time, and said that, after a few discoveries of that kind had been made, he had no further trouble on that head. There was another reason why 100 or 150 volt lamps were desirable, apart from the risk of heating the lamps or destroying them. Many persons, if they had four lamps fitted up in a room, would add to or double the number, never dreaming that this added to the difficulty or danger; now, with 100 volt lamps this danger was much lessened, and besides this the lamps lasted much longer. He knew some people held a different opinion, but he had proved his view by experience. The secret was, as Mr. Preece had pointed out, that the low volt lamp got dark after a certain time, and more E.M.F. had to be used to drive the current through it, which led either to waste of energy or loss of light. The filaments in the 100 volt and higher lamps were thinner, and therefore there was a much less quantity of carbon deposited on the same area of glass. Such lamps would run from 800 to 1,000 hours without appreciable diminution of light.

Mr. PREECE, in reply, said, as Sir Frederick Bramwell had left, he would not waste time in trying to convince him of the superiority of the watt to the horse-power; he would only say that instead of his knowledge of a watt being that it was $\frac{1}{746}$ of a horse-power, his knowledge of a horse-power was that it was equal to 746 watts. He did not think Sir Frederick had quite grasped his meaning with regard to monopolies; what he objected to were grinding, grasping monopolies, such as in a few instances were a disgrace to this country. But it was quite a mistake to suppose that his ideas were in any way governed by his official position, or by the new Patent Act. He belonged to a department of the Government which always had recognised patents, and there never was an invention brought to the Post-office, patented or unpatented, by anyone, which was not well and amply rewarded. Duplex and quadruplex telegraphy, automatic apparatus, and other things had been brought to the Post-office, and nothing had ever been adopted which had not been more amply remunerated than it would have been by a private commercial company. With regard to the cost of installation, he could not say what it had cost him, but he could fit his house up again, or any house like it, for £7 10s. per lamp. A comparison had been drawn by Mr. Crompton between his cost for gas and that which he

(Mr. Crompton) incurred, but when it was remembered that he had to pay 4s. 9d. per 1,000 cubic feet, which was probably nearly double that paid by Mr. Crompton, it was no wonder that his total expenditure was nearly double. It was quite true that the charge for lamps was high, for the reasons which had been suggested; he had been experimenting very freely, but, since last June, Mr. Upton, the manager of the Edison electric light works in New York, who came to see him, and regretted that he had not a single Edison lamp, sent him a present of 100, and out of 56 he had only lost three since last June. It was a very good lamp, although there was some loss of light after a time. Sir D. Salomons wanted him to allow 10 per cent. for depreciations, but he preferred following the Government system. They paid for everything out of revenue, and had no capital account on which to charge interest. Within the last two years 29,000 miles of wire and 2,000 or 3,000 new apparatus had been put up to meet the contingencies of the sixpenny telegrams, and, although this cost nearly £500,000, it was all paid out of revenue. In the same way he had fitted up his house out of revenue, the money was gone, and he should not dream of putting by 10 per cent. to bring it back again at some future time.

The CHAIRMAN then proposed a vote of thanks to Mr. Preece, which was carried unanimously, and the meeting adjourned.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 1) BILL.

House of Commons, March 26th.

LORD RAYLEIGH, in rising to move the second reading of this Bill, said that it was commonly but erroneously supposed that electric lighting was a recent invention. It was, in fact, discovered at the beginning of the century by Davy, who was well aware of the powerful character of the light, which by contrast seemed to be intensely blue, but was really less blue than the daylight. More recently, the present Mr. Justice Grove, then an ardent experimentalist, showed how a reading lamp could be constructed by passing electricity through a spiral wire at a red heat. The difficulty in the practical development of the art lay almost solely in the production of the electricity, which at that time could only be produced by batteries. But by the introduction of the dynamo machine the art of electric lighting attained a greater and greater development, and at the present time had so nearly attained perfection that 93 per cent. of the whole mechanical power was converted into the electrical form. The next difficulty was in employing electricity on a small scale; but the discoveries, almost simultaneous, of Edison and Swan, went far towards overcoming these difficulties. The result naturally was that electricity was supposed to be rapidly superseding gas, and gas shares accordingly became much depreciated in value. Then various schemes came before Parliament for the supply of the electric light, and the Act of 1882 was passed, which was termed an "Act for facilitating and regulating" the use of electricity for lighting and other purposes. But it was proposed to effect the object of the Act by more oppressive regulations than were ever before applied to an industrial undertaking. The burden of complaint lay in the 27th clause, by which local authorities should have the option of compulsorily purchasing undertakings for electric lighting after 21 years. In the event of disagreement as to the price, the question was to be submitted to arbitration, and it was provided that the price to be paid for the undertaking, plant, &c., should be its value at the time of purchase—i.e., when the machinery might be much worn or even obsolete. What was still more surprising was that when the Bill was first introduced into the House of Commons the period was seven years. It was, however, extended by the Select Committee of that House to which the Bill was referred to 14 years, and their lordships further enlarged the time to 21 years. If the terms of purchase had been reasonable the mere shortness of time might not have constituted an obstacle to the working of the clause. But no capitalist would care to invest his money in electrical enterprises on such terms as the Act imposed. Those terms in effect were that if the enterprise failed the loss should fall exclusively on the capitalist; but if it should be successful the local authorities should have power to step in and buy the concern on utterly inadequate terms. How could such a clause permit the proper development of any scheme of electric lighting? It might be that the powerful interest of the gas companies was arrayed against electric lighting enterprises. He was unwilling to believe that Mr. Chamberlain, who was then President of the Board of Trade, was actuated by anything else than a desire for the public interest. It was a difficult and wide question how far local authorities could usefully enter into industrial enterprises of this kind. He would not enter into that question, though he would remark that the electric light did not stand in the same position as water supply, which was an absolute necessity, or even as the manufacture of gas, of which almost as much was known as could be known. At the time the Act was passed it was generally supposed that the electric light would be a great success, and the Board of Trade desired that the benefit of that success should be shared by the public and that it should not go entirely to private companies. It seemed to him that there was too much jealousy at the present day of a private company making large profits. Most undertakings were more or less of a speculative character, and if some were great successes others were miserable failures, so that one ought to be balanced against the other. The promoters of the Act in endeavouring to advance the public interest really inflicted great injury on the public by preventing them from having any chance of getting the electric light for many years. Although he believed a great mistake was made at the time of the passing of the Act in 1882, he was willing to admit that the subject was one of considerable difficulty. The Bill was not seriously debated in either House of Parliament, but it had the advantage of consideration by a Select Committee of the House of Commons, under the presidency of Mr. E. Stanhope. That Committee took the evidence of experts and heard counsel who represented the various interests involved. He must go further and admit that some of the witnesses on behalf of electric lighting examined before this Committee seemed to think that 21 years might possibly suffice as a minimum period, not, however, in conjunction with such terms of purchase at the end of the period as those embodied in the Act. From another point of view he thought they need not altogether regret that something in the nature of a wet blanket was thrown by the Act over the feverish speculation at that time. During the last two years he could not think the Acts had done any great public injury. Many mines and large ships had been lighted by electricity, and the last two years had been a very favourable time in other respects. Labour had been cheap and capital could easily have been obtained on reasonable terms. As soon as it became clear that matters were at a deadlock, endeavours were naturally made to obtain some relaxation of the very stringent provisions of the law. At the suggestion of Mr. Chamberlain, who was then at the Board of Trade, a Committee was appointed of which the noble lord opposite was chairman, and among its members were Sir Frederick Bramwell and others who were well qualified to advise in matters of that kind. The present Bill was, in fact, the outcome of the deliberations of that Committee. When they considered in what directions it would be possible to obtain a relaxation of the present law, the most obvious one that suggested itself was a prolongation of the period of 21 years, more particularly if that prolongation could be accompanied by some less unfavourable terms of purchase. This was the view of the matter which had commended itself to his noble friend who had communicated the second Bill to the trio now before the House. If the question were merely one of raising a large amount of capital in order to start an enterprise of this kind once for all, it was likely enough that such a relaxation as he had spoken of would meet the circumstances of the case. But they could not shut their eyes to the fact that, in so experimental an enterprise as electric lighting must be for many years, it would be impossible for a company to lay out a large sum in the first instance, in the full confidence that they would obtain a fair remuneration for their outlay. They would establish the system on a comparatively small scale at first and then would gradually extend it. In that case it was obvious that a comparatively small capital would be required in the first instance, but from time to time they would have to go into the market in order to raise fresh capital. In what position would the company be to effect that object? After a considerable fraction of their terms had elapsed they would be in such a position that it would be impossible for them to attract fresh capital to the enterprise. Moreover, the interests of the public would be by no means served during the latter part of such a term. During the later years the company would hesitate greatly about embarking on any improvements or extending the area of their operations. After considering the objections which he had endeavoured to place before their lordships, the Committee came to the conclusion that a solution of the question could not be found in that direction, and they proposed that the two competitors, lighting by gas and lighting by electricity, should be put on the same footing in respect not only of privileges but also of obligations. The obligations imposed by the Bill were more severe than anything in the existing law. One of the clauses relating to the compulsory supply of electric light provided that the company should be required to supply electric light at any point within 25 yards of their mains. The important question of the raising of additional capital was provided for by the adoption of the corresponding provision from the Gas Acts known as the auction clauses. The object of securing to the public part of the benefits of the undertaking was, to a great extent, obtained under the provisions of the Bill by the adoption of what was known as the sliding scale of the Gas Acts. If a company were able to supply gas at a lower rate, then in accordance with that they would be at liberty to increase the dividends paid to their shareholders. By this arrangement a company would have every inducement to consider efficiency and economy, and at the same time, if circumstances were favourable, both the public and the company would be benefited. At the present stage of the question he did not wish to commit their lordships further than to the opinion that the obstacles should now be removed which practically forbade the attempt to supply electricity publicly on a large scale under the Act of 1882. If the suggestion of the noble viscount who had another Bill on the same subject were adopted, the exact form of that remedy might be well left to a Select Committee of that House, or of both Houses of Parliament. What he particularly wished to emphasise was that too much time had been lost already, and it would be a matter of great regret if further delay was allowed to intervene so as to prevent a fair chance being given to this most interesting application of modern discovery and invention, which promised to do much to relieve the gloom and unhealthiness of life in our great cities. The noble lord concluded by moving the second reading of his Bill.

LORD HOUGHTON said that Her Majesty's Government had no objection to the second reading of this Bill provided that if the motion of the noble viscount to refer the two Bills to a Select

Committee should not be carried, the noble lord would defer the committee stage of the present Bill till the Government Bill on the same subject had passed through Committee.

The Bill was then read a second time.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 2) BILL.

VISCOUNT BURY, in moving the second reading of this Bill, said that although it went in the same direction it did not go so far as that of his noble friend. The Bill to which the House had just given a second reading was a companies' Bill, as it put the undertakings of the electric lighting companies on equal terms with those of the gas companies. But he believed that the interests of the public would be best served if a term were given at the end of which the electric lighting undertakings should belong to or should be capable of acquisition by the local authorities. His noble friend, on the other hand, gave the electric lighting companies a perpetuity like the gas companies. The term fixed by the Bill which he was now moving was 42 years. He had no objection to the greater part of his noble friend's Bill, but it would be in the interests of the public that both should be referred to a Select Committee. If the Government had prepared a Bill on this subject why had they not brought it on before instead of wishing to delay these Bills? Legislation was urgently required on this subject, as the Act of 1882 had made electric lighting altogether an impossibility. He did not know of a single place which had been lighted under it. It had entirely frightened capitalists away, as no one would invest money in a concern which could be sold for the price of old iron at the end of 21 years. He proposed to give a term of 42 or 63 years, at the end of which period the local authority would have to pay the price of a going concern.

The Bill was then read a second time.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 1) BILL.
ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 2) BILL.

VISCOUNT BURY moved that these two Bills should be referred to a Select Committee. He said that the matter must be dealt with to a great extent on expert evidence. The principle to which he attached importance was that the term for the purchase of the undertakings should be extended from 21 years to a much longer period, and the object of the Committee would be to inquire from experts what was the shortest term that could be given for working which would permit of capital being raised for electric light undertakings.

LORD HOUGHTON said that Her Majesty's Government had no complaint to make against either of the noble lords; on the contrary, they quite admitted that the present position of electric enterprise fully warranted them in bringing in these Bills. Although the Electric Lighting Act of 1882 contained some very valuable provisions, nevertheless he did not doubt that the time had arrived for relaxing some of its most stringent clauses. The Board of Trade had, in relation to this matter, to consider three separate interests—those of the inventors, those of the local authorities, and those of the public. Her Majesty's Government believed that electric lighting had a very brilliant future before it, provided sufficient security was taken that new and perpetual monopolies were not created. He objected to the Bill of the noble lord on the ground that although it was politely called an amendment Bill it was really intended to entirely destroy the Act of 1882 and to establish a new series of vested interests. Again, the Bill of the noble viscount would create a more dangerous because a more insidious form of monopoly. What Her Majesty's Government were prepared to do in their Bill was to extend the *maximum* term during which a provisional order should remain in force from 21 years to 30 years, and with the consent of the local authority to 42 years from the date of the concession, the companies to have three months' notice in order to enable them to arrive at some new arrangement. Her Majesty's Government, however, could not consent to their Bill being referred with those now under discussion to a Select Committee. He therefore appealed to the noble viscount to withdraw his motion for referring these Bills to a Select Committee, or at all events to postpone it until he had seen the Government measure which would be laid before the House in a day or two. In his opinion, this subject could be better discussed in Committee of the whole House than by a Select Committee.

VISCOUNT CRANBROOK asked whether it was intended that the three Bills should be referred to a Select Committee.

LORD HOUGHTON replied in the negative.

VISCOUNT BURY remarked that an extended term of 30 years would not be sufficient. If the noble lord did not intend that the Government Bill should be referred to a Select Committee, and refused to agree to a further extension of the term beyond 30 years, he should go to a division upon his present motion. If the noble lord, however, would agree to refer the Government Bill to the same Select Committee to which these Bills were to be sent he would gladly withdraw his motion.

The DUKE of RICHMOND and GORDON said that when the House had seen the Government Bill it would then be for their lordships to decide whether the three Bills should be sent to the same Select Committe.

EARL GRANVILLE was understood to assent to that proposition.

The discussion upon the motion was then adjourned.

REFORM IN THE FRENCH TELEGRAPH DEPARTMENT.

MONS. GRANET, the Minister of Posts and Telegraphs, in a recent report to the President of the French Republic, strongly urged the necessity of combining in one department the technical and traffic branches hitherto kept distinct and separate. In the course of the report he stated that when in 1878 the separate administrations of posts and telegraphs were united under one executive, the difficulty (due to the essential difference between the two services) presented itself as to the best course to be pursued: whether to adopt a slow and progressive fusion depending on the gradual education of the employés whose qualifications had necessarily to be largely increased, or an immediate blending of all the elements at all similar, postponing the fusion of those whose systems were altogether divergent.

The latter course was adopted, as it was thought that prompt and energetic measures would more readily overcome all jealousy of innovation, and the natural resistance and opposition to a reform—so wide spread—to so complete a revolution of the existing state of things.

The experiment turned out a success, so much so that to-day the separation of the two services would prove more difficult than was their fusion.

But, on April 23rd, 1883, in addition to the already existing traffic service, which, up to this date, included the direction, inspection, and control of the transmission of all correspondence whether postal or telegraphic, the discipline of the staff, and finance, there were added three fresh departments, viz., the travelling service, the maritime service, and the technical service. The first two named explain themselves. The last included the construction and repair of lines, the fitting up of offices, instruction of staff, and instrument making and repairing.

Mons. Granet gives, as reasons for uniting the technical and traffic departments—that they depend entirely on one another; that the scientific department only exists for the sake of the traffic; that the latter could not survive without the assistance of the former; that the existence of two departments, completely distinct in their officials, systems, and training, both engaged on the same work is only productive of antagonism and delay, from jealousy between the two services, and through each department being obliged to get the approval of the other on every detail connected with the work, All improvement, all advance, was thus very much hampered.

The proposal of the Minister of Posts and Telegraphs has been accepted, and the President of the Republic has decreed that from May 1st, 1886, the technical and traffic departments of the French telegraphs shall be united under one administration under the control of a council of six chief inspectors, and with the head quarters at Paris.

The principal officials of the present technical and traffic departments are to be re-appointed and re-distributed according to their rank and seniority.

THE TELEPHONE CASE.

THE UNITED TELEPHONE COMPANY, LIMITED *v.* BASSANO AND SLATER.

Judgment of Mr. Justice North, delivered Saturday, March 27th, 1886.

MR. JUSTICE NORTH: The letters patent bear date the 30th of July, 1877, and were granted to Mr. Thomas Alva Edison, a gentleman whose brilliant discoveries with respect to electricity have rendered his name famous throughout the scientific world, and they relate to improvements in instruments for controlling by sound the transmission of electric currents and the reproduction of corresponding sounds at a distance, or, in other words, to telephones. The letters patent contained at first 30 different claiming clauses, but these have by disclaimers at different times been reduced to one only. The defence put in originally in the action merely denied the infringement of the patent, but after issue joined the defendants, by leave, put in a further defence by which they set up that the invention, the subject of the patent, was not novel or useful, that Edison was not the first inventor, that the specification was insufficient, and that the invention had been published in this country before the date of the letters patent in 21 several publications. At the trial, however, most of these points were dropped, none of the alleged cases of anticipation was relied upon or gone into, the validity of Edison's patent was not substantially challenged, and three simple issues were raised by the defendants' counsel. The final clause of the specification, as last amended, now runs as follows:—"I would observe, in conclusion, that I do not claim generally the transmission and reproduction of sound by increasing and decreasing the resistance of the circuit, nor do I claim separately any of the parts or arrangements hereinbefore described and illustrated in the accompanying drawings except as hereinafter mentioned, but I claim as my invention—first, in an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of electric tension regulators, substantially as hereinbefore described, for varying the resistance in a closed circuit, substantially as set forth." The claim thus being for a combination of diaphragm or tympan with electric tension regulators, as and for the purposes described, the first two points raised by the defendants are—(1) that they have not used a

diaphragm or tympan which falls within the specification; (2) that they have not used a tension regulator which is within the specification; and that, therefore, they have not taken either of the two things the combination of which alone is claimed. If the defendants succeeded on either of these points they would be entitled to judgment, but in case of failure on both they set up a third—viz., that Edison's invention is not commercially useful, having regard especially to the tension regulator portion of it, and that there is no evidence that any such tension regulator as he describes was in actual use. I do not stop to consider in detail the various discoveries and inventions the improvements upon which are the subject of the letters patent now before me. It is sufficient to say that before the date of that patent it was known that if two similar plates or tympans capable of vibrating were placed a short distance apart and were mechanically connected the vibrations caused in one of them by speaking to it would be reproduced in the other, and this would in its turn cause pulsations in the air corresponding with those which made the first vibrate, and thereby reproduce articulate speech. It was also known that by the use of the electric current certain sounds, such as musical notes, could be transmitted to considerable distances, but no mode by which articulate speech could be reproduced at long distances had yet been worked out. The question for solution was—How can the pulsations of air caused by speech be made to operate upon a continuous electric current in such a manner that the current will reproduce vibrations or pulsations of air corresponding with those which first operated upon it? The mode in which Edison solved the question was by the use of a diaphragm to receive the pulsation of sound and operate correspondingly by causing variations of resistance in the electric current, and the arrangement by which this operation was accompanied was what he calls an "electric tension regulator." It is necessary, therefore, to consider these two things separately. But before doing this I should refer to the general description of his invention given by Mr. Edison in his letters patent. He says in his specification:—"This invention relates to that class of electrical instruments in which sound becomes one of the elements in the transmission of the communication and a corresponding sound is produced at the receiving station, so that oral communication can be sent by electricity and clearly distinguished at the receiving station. Musical tones may also be sent, but my present invention is specially available in transmitting and receiving oral communications. In transmitting musical tones the respective notes each have a definite period for each vibration, hence there is a response at the receiving end from the notes that vibrate in time with the electric pulsations sent; but in speaking there is little change in the musical tone, but considerable change in the modulations and inflections of the voice. In my present invention I make use of the vibrations given to a diaphragm or tympan by speaking into a resonant case to produce a rise and fall of electrical tension upon the line with such accuracy that the electric pulsations or waves will represent the atmospheric sound-waves produced by articulation, and an electro-magnet at the receiving station will respond to the electric waves in such a manner as to reproduce the articulation by acting upon a resonant plate. The transmitting instrument in a complete form is represented in sections in fig. 1, and fig. 2 represents a receiving instrument which may be employed with it. Referring to fig. 1, the resonant tube or box, *a*, is of a size and shape adapted to being spoken into, the same having an opening at one end or side and a diaphragm or diaphragms, *b*, against which the sound-waves from the human voice act, and these and the motion that the diaphragm receives are the means of producing the rise and fall of electric tension on the line by the devices hereafter set forth, so that the battery, B, connected to the line, *l*, will transmit a greater or less current to the distant electro-magnet, *m*, in fig. 2, and increase or lessen the magnetism of the cores, and in so doing act upon a resonant plate, *c*, and develop sound corresponding to the articulation at the transmitting station. The general features thus described pervade my entire invention, but, in developing the same, many useful and important modifications and variations have been made which I will proceed to set forth." After referring to some details which are not of importance for the present purpose, the inventor proceeds as follows:—"The next feature requiring consideration is the character of the diaphragm in the speaking instrument. Many materials have been used by me, such as metals, horn, vellum, celluloid, ivory, &c., but almost all of them produce a prolonged or second vibration from their own resonant character, hence the articulation is defective and the sound vibrations blend." His Lordship read a further extract, in which the inventor states his preference for mica, and continued: He then gives certain details with reference to his tension regulator, which I pass by for the present with the observation that he then refers to a diaphragm "covered with plumbago," which differs somewhat from what he had previously described. He then proceeds as follows:—"I sometimes perforate the diaphragm 10, fig. 18, and place a strip of elastic material, 40, across the said diaphragm over the hole, and upon this a piece of foil, so that the same responds to every weak vibration, and in some cases two or more diaphragms are provided at different sides of the resonant box, each with its own tension regulator, the diaphragms being either the same or of different sizes, characters, or tensions, so as to respond to varying sounds or acoustic conditions, the various tension regulators being all in the electric circuit, line 18. This will produce greater rise and fall of tension for longer lines in consequence of the diaphragms acting simultaneously on the tension regulators." In another passage he describes a totally different arrangement for a diaphragm. "A plate supported eccentrically and free at its edges when placed in the speaking tube responds advantageously to the tones of the voice; the circuit with this plate is completed through one or more tension regulators placed round its edges." In that passage the inventor does not use the phrase "diaphragm or tympan" at all; but it is clear that he is there referring to one form of the arrangement which is elsewhere indicated by that name. From these various extracts from the specification it is obvious that Mr. Edison does not confine himself to one kind of diaphragm. It is clearly pointed out that diaphragms may vary in number, and may be one, two or more. When more than one in number they may be of the same or different sizes, characters, or tensions; they may vary in position and may be at the ends or sides or wholly or partially across the instrument, or one may be mounted upon a perforation in another. They may differ in material, though the inventor gives reasons for preferring mica, and they may be set up in different ways, for they may be strained if constructed of a membraneous material like vellum, which requires straining; or if the material, like mica, does not require to be strained, the diaphragm may either be secured at its edges, or it may be supported eccentrically with the edges free. The specification frequently refers to a diaphragm or tympan as though they were synonymous terms, and an argument is founded upon this that nothing could be a diaphragm within the meaning of Edison's specification unless it were more or less a tympan or drumhead also, and it was said that nothing of that character was found in the defendants' instruments. Mr. Conrad Cooke, in particular, made a strong point of this. But I agree entirely with the opinion of Lord Justice Fry that the diaphragm described is susceptible to vibration produced by the voice, and this is common to a tympan also; and I do not think that calling it a tympan means more than this. And even if it could be said that in some form Edison's diaphragm was not a tympan at all, I do not think it material that a thing is called by an inapt name when I find the thing itself described with sufficient fulness and clearness for all practical purposes—as is the case here. The next point is as to what is the diaphragm referred to in this specific case. The ordinary meaning of the word is a partition or separation; and in the present specification I think it clearly means something which is capable of vibrating, and which divides the air on one side of it so as to allow of differences of air pressure on the two sides which produce the necessary vibrations of the diaphragm. It is proved to be quite immaterial on which side of the diaphragm the tension regulator is placed, and therefore it is not in any way essential that the diaphragm should separate one portion of the instrument from another part of it. In point of fact, one form of instrument shown in Edison's specification has a tension regulator on the side of the diaphragm on which the speaker is. I have read from the specification Edison's description of the object of the diaphragm; and the witnesses on both sides concur in the view that its function, as indicated throughout that specification, is to receive and take up the air-waves and pulsations of sound produced by the voice and vibrate in accordance with them, and thus produce a varying or changing pressure upon the tension regulator resulting in a varying use of all in the electrical resistance of the circuit which, the specification points out, must be closed, and further that the form or shape of the instrument which thus gathers up the air-waves is immaterial except in degree. I think the evidence of the defendants' witnesses, Prof. Forbes and Mr. Conrad Cooke, when subjected to a little pressure in cross-examination, quite as clear upon these points as that of the eminent witnesses called for the plaintiffs. It is necessary now to consider the form of the instrument the defendants have made and sold. It consists of a conical hollow mouthpiece made of thin black wood, into the open, larger end of which the voice of the speaker passes. Towards the lower end of the cone the wooden part suddenly becomes larger and forms what has been distinguished as the black base. Within this is a cylindrical chamber into which the smaller end of the cone opens, and which chamber is of considerably larger diameter than such opening. To the sides of this chamber two points or blocks of hard carbon are firmly fixed, and a pencil of similar carbon with attenuated points is supported at its ends by each pair of blocks, the points resting lightly in a larger cavity in each of the supporting blocks and being in what has been called "loose contact" with them. The other end of this cylindrical chamber in the black base is then closed by its being fastened firmly to a piece of red stained wood, which is the portion of the instrument furthest from the speaker's voice, and has been called for distinction the "red back." The carbon blocks and pencils form the defendants' tension regulator, about which I shall have to say more presently, and they are connected in the usual manner with a line wire in a closed circuit, so that the electric current passes from one block to the other through the pencil which connects them. A portion of each pencil is opposite to the opening at the thinner end of the cone, and is visible through it. When the black cone is spoken into, the tension regulator is affected in such a manner that articulate speech is reproduced at the receiving end of the closed circuit, and the question is whether the means by which such result is obtained are protected by the plaintiffs' patent. It appears quite clear to me that the use of the red back is the use of a diaphragm within the meaning of that patent. The arrangement of the black cone and base, the red back, and the tension regulator are substantially the same thing as the transmitting instrument fully described in Mr. Edison's patent, except that the tension regulator is on the nearer instead of the further side of the diaphragm, which is represented in the defendants' instrument by the red back, and this variation of its position is admitted

to be of no importance. Indeed, it is proved that when the pulsations of air caused by the voice are made to strike upon the back or outside of the red back the defendants' instrument speaks quite as well as, and under some circumstances better than, it does when the voice speaks into the mouthpiece in the ordinary way. It is true that in the defendants' instrument the diaphragm is made of wood, which is not mentioned by Mr. Edison as one of his materials, and the use of which substance as a diaphragm is said to have some disadvantages. But a patent cannot be infringed with impunity by the adoption of an inferior material for a given purpose in lieu of a more efficacious article indicated by the patent for the same purpose, and it is obvious from the use of other instruments, and from the defendants' own instrument, that wood will answer very well for the purpose of a diaphragm. It is not necessary for me, for the purposes of my judgment, to say more than that by the use of the instrument of which the red back forms a part the defendants have used a diaphragm within the meaning of the plaintiffs' patent. But it has been clearly proved that if the red back is taken away the rest of the defendants' instrument still operates as a good telephonic transmitter; and the question whether any combination in which the black wooden portion of the instrument, consisting of the conical mouthpiece with its back base, or either of those parts, is included is protected or not has also been fully argued, and as I have considered it carefully and have formed a clear opinion upon it, and it may be important to the parties to know what my opinion is, with a view to subsequent action, I proceed to deal with it. I entertain no doubt that the use of the black part of the defendants' instrument, as well as the red back, is the use of a diaphragm within the meaning of Edison's specification. Each of those parts separates the air on one side of it from the air on its other side, and thus allows the differences of air pressure to exist on its opposite sides which render it susceptible of vibration, when the air-waves come in contact with it, and it gathers and takes up these sounds and vibrates in accordance with them and transmits them to a tension regulator. The experiments tried by Dr. Hopkinson, the details and results of which were fully explained by him, and were not challenged by the defendants, prove this to demonstration. The trials of the several portions of the defendants' instrument as parts of a telephone which acts solely by mechanical vibration were completely successful, and the instrument spoke perfectly. The defendants' counsel attempted to make out that the operation of the defendants' instrument was produced solely by the direct impact of the sound-waves upon the pencils of carbon in the defendants' tension regulator, and that the vibration of the black cone and base and the red back had nothing to do with it. But this is quite inconsistent with the result of the experiments and also with the proved facts that the defendants' instrument speaks better when the outside of the red back is addressed than when the voice enters the mouthpiece, and that it speaks quite as well when the aperture from the narrow end of the cone into the cylindrical chamber is closed by a cork; when the cone is continued down to the red back, as in J. H. 2; when the pencils are moved further apart in the cylindrical chamber, so as to be sheltered from the direct action of the voice, as in J. H. 3; and when the outside of the black cone is spoken to, as in its normal condition. In fact there is no real conflict of evidence upon the question whether these portions of the defendants' instrument performed the functions of the diaphragm as such functions are described in the plaintiffs' specification. The defendants' witnesses, when pressed in cross-examination, confirm the direct evidence of the plaintiffs' witnesses. The defendant Bassano says that these portions of his instrument are really for a totally different purpose; that the function, or main function, of the black cone is to concentrate the air-waves from the voice on the tension regulator; that the black base is to hold the carbon-blocks which support the pencils, and that the red back is merely a support for the rest of the arrangement. But even if this be so, yet if they discharge the function of the plaintiffs' diaphragm they are none the less an infringement. But the most important contention on the part of the defendants is that even if the above-mentioned parts of their instruments so perform the functions described still they do not come within Edison's specification. In other words, they attempt to circumscribe the area of that specification and limit it to particular kinds of diaphragm and tension regulators as much as possible. This is clearly shown in the answers of the defendant Bassano to his counsel's question whether he considered the black cone or base, or the red back, to be diaphragms, to which he replied, not by a simple negative, but by saying he did not consider them diaphragms according to the specification of Edison, and the other witnesses for the defence take the same line. So, too, the defendants' counsel press upon us that Edison's diaphragm is a distinct portion of his instrument figured in his illustrations, distinguished by a letter, and shown in particular positions, and also further identified as being made of mica as the material preferred, and being in every one of these points something quite different from the parts used by the defendants which are said to be infringements. But I have already pointed out that the specification is not confined to one special form of diaphragm. On the contrary, it describes diaphragms differing in size, number, material, form, position, and otherwise, though the common function they are to perform is clearly shown. Under these circumstances it is impossible for me to hold that the patentee is limited to any special form. Indeed his claim is the combination of a tension regulator with "a diaphragm or tympan," not confining it to any special form, and I have heard no complaint that the claim is too large in this respect. The contention of the defendants appears to me incapable of being maintained, either upon principle or authority. As regards principle the patentee discovered a very remarkable new manufacture, and described its essential conditions, and pointed out how it was to be performed, and indicated several practical modes of carrying it into effect, and the law does not require him to describe every way of carrying it out, or limit the protection it confers to the modes particularly described. If the defendants place a diaphragm in their apparatus which performs the functions of the diaphragm in the plaintiffs' apparatus, they cannot escape the charge of infringement by making a non-essential variation in the position or form of the diaphragm material. And, as regards authority, the decision of Lord Justice Fry in the case he decided seems to me to cover the present case. In the specification and drawings of the plaintiffs' patent the diaphragm is always referred to by the letter *b*, and this is made to operate by its vibration on an electric tension regulator in physical, but not necessarily in mechanical, connection with it. The regulator first described is of compressible bunches or tufts of elastic fibre, forming part of the circuit connected either by a diaphragm, spring, or secured by solder, or by a delicate cork centre piece, or with a piece of platinum foil, *x*, in contact with the fibre; in all instances the telegraphic circuit being made by a thin strip of platinum or similar material extending to the centre from the line or battery connection. In that case it is quite clear that the piece of platinum foil is not described as part of the diaphragm nor exposed to the air waves, though no doubt it is affected by the vibrations of the diaphragm through the cork or the spring; but is described as part of the tension regulator, and actually forms an essential part of the electric circuit. The alleged infringement before the Court on that occasion was Hunning's transmitter. In that the diaphragm, *b*, had been taken away altogether and the platinum foil, *x*, was left exposed to and received the sound waves, and it was held by Lord Justice Fry that the platinum foil, though described as a separate independent portion of the instrument and as part of the tension regulator and not of the diaphragm, was in fact a diaphragm, which, being combined with the tension regulator as described in the specification, was within the scope of Edison's invention and was an infringement. It was argued in that case, as here, that the absence from the defendant's instrument of a diaphragm corresponding with *b* saved that instrument from being an infringement; but the argument failed, and the decision in that case is an authority—if authority be necessary—which applies to the present case and disposes of that argument. It was also said by the defendants that their instrument does not require anything in the nature of a diaphragm; that it will act perfectly without, and therefore that it cannot be an infringement of Edison's combination. And they appeal to the experiments made with carbon blocks and pencils. Those made by the defendants' witnesses were successful to some extent; those by Sir William Thomson did not answer so as to produce articulate speech. It is obvious that there is still room for further investigation in this direction, but the question whether the defendants could dispense with a diaphragm or not is not now before me for decision. As a matter of fact they never have done so, for they have never used thin carbon blocks and pencils in practice except in combination with the cone, the black base, and the red back, each of which, as the defendants' witnesses admit, does assist, by intercepting the sound waves vibrating synchronously with them, and so acting on the tension regulator, and they have therefore adopted Edison's combination unless the tension regulator they have used is outside his specification, the point I now proceed to consider. The electric tension regulator of the Edison specification is the apparatus forming a joint or link in a closed circuit, by which the vibrations of the diaphragm are made to produce a rise and fall in the electric current passing along the line wire by varying the amount of resistance, such variation being caused by increasing or diminishing, by the change of pressure, the area of surface contact within the regulator. In a passage in the specification which I have already read, Edison says that the motion of the diaphragm is the means of producing a rise and fall of electric tension on the line by the devices hereafter set forth. He also says, "I find it is not practicable to open and close the line circuit in instruments for transmitting the human voice; the circuit to the line must be always closed, and the transmission be produced by a rise and fall of electric tension resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several which will hereafter be named, but I find the most delicate to be small bunches and tufts or discs of semi-conducting fibre, such as particles of silk, and an intermediate conducting or semi-conducting material; this device I call an electric tension regulator; it is more or less compressed according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed, or lessens as the fibre expands." At page 7, line 15, he describes an arrangement shown in fig. 10, in which the diaphragm is placed at the end of a resonant chamber, and has at each side of it springs with points made of compressed plumbago, mixed preferably with gum or any substance not liable to rapid decomposition, or the "elastic or fibrous tension regulator aforesaid may be used." And after pointing out how this operates to vary the current by creating greater pressure upon the plumbago points on the two sides alternately, he says that, as the tension regulator of fibre or plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak. A little further on he speaks of another arrangement by which a plumbago contact point is so arranged as to present a semi-rigid point for contact, so as to pre-

vent a rebound and allow of a slight yield when the plumbago is pressed by the diaphragm. Without attempting to go through all the various forms of tension regulator mentioned in the specification, in some of which carbon is not used at all, I refer to page 10, line 3, where the patentee says: "In preparing the tension regulator I find in some cases that it is preferable to use lamp black mixed with pure plumbago, amorphous phosphorus, and a very small amount of non-conducting material, such as rubber dissolved in a solvent that will entirely evaporate." It appears clear to me, as it did to Lord Justice Fry and Lord M'Laren, that Mr. Edison did not attempt to describe every form of tension regulator to be used with instruments made under his specification; but Lord Justice Fry pointed out that the regulators he describes have three essential properties—(1) that of compressibility, in order that the area of surface contact may be capable of being increased by pressure, and the resistance to the current diminished accordingly; (2) that of resiliency, either from the natural elasticity of the substance employed or produced by artificial means, so that when the pressure is removed the material may return to its normal position, and thus check the current, which had been increased by its compression, and be in a position to repeat the operation time after time; and (3) that of semi-conductibility. In the present case the scientific witnesses on both sides agree that these three qualities must be found in Edison's tension regulator. The question then is whether the hard pencil carbon used by the defendants in their instrument, as I have explained, comes within the description of "electric tension regulators substantially as hereinbefore described," as used in Edison's specification. The plaintiffs' witnesses say that it does, for that it is semi-conductive, compressible, and resilient. The defendants' witnesses say that it does not, for it is not semi-conductive, not compressible, and therefore not resilient. And yet, when the evidence is considered attentively, there is very little, if any, difference between them after all. It is merely a question of degree. For instance, it is said by Mr. Conrad Cooke that hard carbon is not appreciably compressible, and no doubt it may be said that in comparison with the tufts of fibre described by Edison a piece of hard carbon, or a billiard ball, is not compressible. But if dropped from a sufficient height upon a hard, flat surface a billiard ball is compressed to half its diameter; and the carbon pencils of the defendant are compressible in the same way. In fact, Mr. Bassano himself says that hard carbon must be to some extent compressible in virtue of its elasticity, the same as a billiard ball is elastic, and Mr. Cooke says that when the defendant's carbon pencils are made to a point they are exceedingly compressible at that point; and the evidence is clear that even the slight motion caused by the effect of the voice in the defendant's instrument suffices to produce such a movement of the pencils in relation to the carbon blocks that by reason of the inertia of the pencil, a squeeze or compression is produced in the substance thereof to such an extent that the area of surface contact is appreciably affected thereby, and that it is by means of the variations thus obtained that the defendant's instrument is made to reproduce articulate speech. Again, it is said that hard carbon is not semi-conductive because it is a good conductor. But this also is a question of degree. Mr. Conrad Cooke says that hard carbon may be called a partial conductor—it is a pure question of comparison—that comparing it with the line wire of copper it might be called a semi or partial conductor, or even a bad conductor, certainly an imperfect conductor, and that for Edison to call carbon a semi-conductor is a fair expression having regard to the circuit in which it is placed, and the defendant Bassano agrees with this. But it is also said, even if the defendants' hard carbon blocks and pencils have the attributes of Edison's tension regulator, a regulator of hard carbon is still quite a different thing from any described in that specification. To this there are many answers. In the first place I have already pointed out that Edison's specification does not limit him to specific forms, or to plumbago, or even carbon only. In the next place Edison does specifically describe a form of tension regulator with points of compressed plumbago, which is one form of carbon, and Mr. Imray's evidence is clear that there is no difference in operation between the plumbago point there described and the carbon used in the Blake, the Ader, the Gower-Bell, the Theiler instruments, and in the defendants' instruments. Further than this, I consider the decisions of Lord Justice Fry and Lord Maclaren both dispose of the contentions of the defendant upon this point. In the Scotch case it was held that Theiler's instrument was an infringement of Edison's, and in that the tension regulator consisted of pencils of hard carbon exactly similar to the defendants', the effect being produced by the inertia of one weighted pencil suspended across and pressing lightly against two other pencils of the same substance, to which the vibrations of air were communicated by a diaphragm; and in the case tried by Lord Justice Fry, the tension regulator in the infringing instrument was made with small pieces of coke, which, as the learned Judge pointed out, is only hard carbon in a somewhat different form. Before passing away from this part of the case, I desire to refer to the very straightforward evidence given by the defendant Bassano in cross-examination. He says: "In the defendants' instrument the sound waves are taken up to some extent by every part of it, the mouth-piece, the black base, and the red back, whether you speak into it or to the outside. The vibrations of those parts are communicated to carbon blocks fixed to them, and the blocks and the pencils resting on them have motion relatively to one another. The result is a change of position in the carbon surfaces in contact, accompanied by some pressure. This, to the extent of the compressibility of the carbon, varies the area of the carbon surfaces in contact; this varies the resistance of the electric current synchronously with the vibrations caused by the sound waves, and the circuit being a closed one, the result is that the sound waves created by the voice at the transmitting end are reproduced at the receiving end to the person listening." This is a very fair description of the defendants' instrument and its mode of operation, and I am of opinion that it is like Edison's combination of a diaphragm or diaphragms vibrated by the voice with an electric tension regulator consisting of a semi-conductive, compressible, and resilient substance for varying the resistance to the electric current in a closed circuit, and that it is within the scope of, and an infringement of, Edison's specification. The third point raised may be very shortly disposed of. It is that Edison's invention, especially the tension regulator portion thereof, is not commercially useful, and has never been in actual use. If this be so, it does not follow necessarily that the patent is bad. Lord M'Laren disposed of that argument by saying, "It does not appear that any of the mechanical combinations described in the specification ever came into commercial use, probably because, as may happen in the history of even the most original and valuable inventions, these were immediately superseded by simple constructions involving the same principle." But in the present case there is direct evidence on the subject. Sir Wm. Thomson proves that he has seen transmitters constructed in some of the forms Edison described in actual use, and has himself used them for years; and that all the forms of tension regulator specifically described by Edison are practically useful, and any one of them could be used as a commercial instrument. Prof. Forbes says that looking at the specification and figures, the mode in which Edison intended the tension regulator to act is as clear as possible; and from a scientific point of view theoretically would act. He could not say if they would act practically or not, as he had not tried them; his impression was that most of them would require large power. Again Mr. Conrad Cooke says that Edison's tension regulator would not act if the diaphragm was taken away, and it was obviously his view that if it was not taken away they would act. Moreover, none of the plaintiffs' witnesses were cross-examined for the purpose of showing that any of Edison's tension regulators would not act. On this point also, therefore, the defendants fail.

LEGAL.

Crossley Brothers, Limited v. Littleton.—In the Lord Mayor's Court on Friday, Messrs. Crossley Brothers, the makers of the Otto gas engine, sued Mr. Littleton for payment of £12 6s. 3d., which they alleged to be due for repairs to a gas engine. The defence was that the repairs were such as were covered by the terms of the six months' guarantee given by Messrs. Crossley upon the sale of the engine. In reply to this, plaintiffs contended that they never sold the engine to Mr. Littleton, but to a Mr. Heath, who re-sold it to the defendant. The evidence for the plaintiffs was that they received at their offices in the Poultry an intimation from Mr. Littleton that the gas engine which he had purchased was not working satisfactorily, and they offered to send a man to see what was necessary to be done. A workman, Goodacre, who was called as a witness, went to the defendant's residence in December, 1884, and altered a catch, after which, he said, the engine worked all right. By direction of Mr. Lupton, Messrs. Crossley's representative in London, he subsequently paid further visits, and effected certain repairs. These repairs were not, he said, such as came within the guarantee; they were probably necessitated by the engine being shaken when conveyed from the Health Exhibition to Mr. Littleton's residence at Sydenham. Mr. Lupton's evidence was to the effect that Mr. Littleton called upon him and made enquiries respecting a gas engine, when he offered him one which was then in the Health Exhibition. Defendant thought this would suit him, and then said he should want the trade discount of 15 per cent. This, witness said, he could not allow, as it would cause unpleasantness with the trade; he offered him, however, a lesser rate of discount. Mr. Littleton insisted on the trade terms, and witness said he could not meet him in that way, but he might get the engine through the trade, and thus secure a larger abatement. He suggested to him the name of a man in the trade, and the defendant went away. The engine was bought by Mr. Heath, and after the latter had re-sold it to Mr. Littleton, an intimation was received that the engine was not running properly. Goodacre was sent down, and after several visits the engine was got to work. Cross-examined by Mr. Corrie Grant, defendant's counsel, witness denied having said that he would send their engineer to arrange terms with Mr. Littleton; he suggested "a man in the trade," and mentioned Mr. Heath's name, but not as their engineer or agent. During cross-examination he first said he would swear Mr. Littleton never came to him to complain of the delay in fixing the engine; had he done so he should have referred him to Mr. Heath, as the matter had nothing to do with Crossley's then; subsequently, however, he admitted that Mr. Littleton might have so called. Mr. Heath, examined by Mr. Haigh, counsel for plaintiffs, said he was a contractor, and was not Messrs. Crossley's engineer, nor was he a servant of theirs in any capacity. In November, 1884, he purchased from

that firm a gas engine, and signed a contract with them. Previously to that he had had an interview with Mr. Littleton, to whom he had agreed to sell the gas engine, at a discount of 10 per cent. from the published price, and 2½ per cent. for cash down. The contract between them was put in writing at his (Mr. Heath's) request. Mr. Littleton paid him for the engine and he fixed it. He received no commission from Messrs. Crossley, but merely purchased from them on the ordinary trade terms. Cross-examined, he said he was at Crossley's on another matter when Mr. Lupton told him there was an order he might get. He went to Mr. Littleton's and told him he had heard he wanted an engine, and was prepared to sell him one. He had not bought the engine then; he did not buy a thing until he had some chance of selling it. This concluded the evidence for the plaintiff. Mr. Littleton said that at the end of 1884 he was fixing the electric light at Westwood House, Sydenham, and wanted a gas engine. He went to Messrs. Crossley's, in Poultry, and told them of his requirements. Plaintiff's representative, Mr. Lupton, told him that they had an engine at the exhibition which would probably suit him, and which could be delivered without delay. Witness claimed the trade discount, for although he was not in the trade he was closely connected with it. Mr. Lupton said he could not think of allowing the trade discount of 15 per cent., but offered him a small reduction, as he was afraid it might offend some of their trade customers to give him the full discount. Witness said he could get a friend to purchase for him at the trade price and hand it over to him for the same price only which he had given for it. As witness was leaving the shop, Mr. Lupton said, "We might as well deal direct, as place the order through a third person," and suggested that they should send him "their engineer." Witness replied that it was immaterial to him how the order was placed. Mr. Lupton said the utmost he could give him was 12½ per cent.; witness accepted that offer and left him upon the understanding that he would send him someone. Mr. Heath came and said he was informed by Messrs. Crossley that he was in want of a gas-engine. Witness said that was true, and Mr. Heath added that the plaintiffs had sent him to take the order for it. Heath offered him 10 per cent., but witness told him he must be under a mistake, for they had already arranged terms, and he was to have 12½ per cent. They eventually agreed to the latter terms, and the engine was sent, witness signing a contract with Heath. A trial run was made about the end of the year, and the result was unsatisfactory. Witness reported the matter to Mr. Lupton, at the Poultry office. Mr. Lupton said they must send someone down to see what was the matter. Goodacre came and rectified the slight derangement which existed; other repairs became necessary; for one thing, the water in the water jacket escaped through the joints into the cylinder. These repairs were done by plaintiffs' workmen. One or two small claims were sent to him at the beginning of the year, but he did not think those claims were seriously made. In June or July last he received a letter asking why the account was not paid. This account was simply to goods delivered, and he thought it had reference to other matters. He called on them and said he did not consider they had any claim against him. He did not see all the accounts; probably the letters had miscarried in the process of delivery. He thought all along that it was with Crossleys he had been dealing, and it was not until now that Mr. Heath was named. There had been some discussion respecting dealing direct, and finally the terms mentioned were agreed upon. Mr. Lupton, recalled, positively denied having said to Mr. Littleton that he would send "our engineer," to take the order from him. He did not in any way promise him, either, that he should have an engine at 12½ per cent. discount. In further cross-examination, he said it may have happened that when Mr. Littleton was going away without having concluded the bargain he called him back; he wanted to get all the orders possible, and rather than lose this chance he called him back and tried to get into further conversation with him. No doubt he mentioned Mr. Heath's name in suggesting that Mr. Littleton might get the engine through the trade. He was quite positive nothing was said about the guarantee after Mr. Littleton came back. Mr. Corrie Grant, in addressing the jury submitted that the point at issue was purely a question of fact, and they would have to decide which of the two stories they would believe. With regard to the guarantee, his contention was that it covered the repairs, payment for which was sued for. Goodacre no doubt spoke from his own experience in saying that the work was not within the terms of the guarantee; he, perhaps, had never done just the same kind of repairs under the guarantee, and therefore stated what he did in evidence. His Honour, interrupting Mr. Grant, said he was afraid he could not tell the jury to find that. The witness stated that the work done was not under the guarantee, he was not cross-examined upon the point, and his statement remained undisputed. How could the jury find a verdict directly against that uncontradicted evidence? A slight discussion between counsel and judge ensued, after which Mr. Grant resumed his address, and submitted to the jury that the substantial question was as to which story was the correct one—that of the plaintiffs who repudiated Mr. Heath as being their agent, or to the defendant, who stated that Heath was sent to him, under arrangement with the plaintiffs, to act for them. If they would declare in favour of his client upon that point, he would be contented. Mr. Haigh having addressed the jury for the plaintiff, the judge, in his summing up, said the first question was, was the work done within the guarantee? He might express an opinion upon the subject, and his opinion was that where the evidence stated that it was not, and that evidence had not been questioned in any way, it was for the jury to give due weight to the fact that the question was not really disputed. But if, notwithstanding this, they thought it was within the guarantee, then the point for their consideration was whether the defendant purchased the engine from Messrs. Crossley or from Mr. Heath. Having reviewed the evidence, His Lordship said, in conclusion, that the defendant said Heath represented himself as coming from the plaintiffs'; but the contract put in was, singularly enough, made out in Mr. Heath's name, and Messrs. Crossley were not mentioned in it. After a brief consultation, the jury found a verdict for the plaintiff.

THE DIFFICULTIES OF SHIP LIGHTING.

MESSRS. R. E. CROMPTON & CO. have been entrusted with the order for wiring the two new gunboats, now being rapidly completed at the Devonport Dockyard—namely, H.M. ships *Landrail* and *Curlew*. The work was given to Messrs. Crompton on their undertaking to complete one boat, the *Curlew*, in six weeks. As each ship is only to be fitted with about 85 incandescent lamps and search lights, this would appear an easy matter to any one not well acquainted with the difficulties involved. The contract, as is now usual with such work for the Admiralty, includes supplying, fixing and fitting all teak casings for the wire leads, and drilling all holes, piercing decks, &c., also fixing all fittings, switches, cut-outs, &c. It is of course well known that on all fighting ships of recent design space of any sort is of the utmost importance, but such a generalisation as this conveys an utterly inadequate impression to the minds of the uninitiated as to the difficulties to be overcome by the electrical contractor in such cases as the *Landrail* and *Curlew*. It is no exaggeration to say that every available space is already occupied either with steam pipes, water pipes, ventilating pipes, speaking tubes, gun-firing circuits, bells, signals and gear of every description, and owing to the existing fittings and the rigorous rules as to piercing watertight bulkheads, it is frequently necessary, in order to carry the wires through a space, sometimes not exceeding a few inches, to turn them upwards through one or more decks, sometimes of steel, until a suitable place is found, and then descending sometimes through the same decks, the wires are at last placed in the necessary position, and an uninterrupted run of a foot or two may be gained before the next difficulty has to be overcome. When it is further borne in mind that in the majority of positions in which the wires are fixed, it is quite impossible for even a small man to stand upright, and that in some specially cramped places even sitting down between decks is a tight fit, it may fairly be concluded that the contractors have no easy task to perform, and that the electrical engineer's lot under these conditions is not too happy, and were it not for the able assistance and advice generally courteously given by the dockyard officials, it would, under these circumstances be next to impossible for contractors to take up such work.

REVIEW.

Electricity Treated Experimentally.—For the use of schools and students. By LINNÆUS CUMMING, M.A., Assistant Master in Rugby School. Rivingtons: Waterloo Place, London.

For the purpose of directing a teacher in a course of lectures, this book is, we think, admirably adapted. There are plenty of very clear illustrations of experiments and apparatus and sufficient, but not too much, letterpress. A number of excellent examination questions with answers to the same are given at the end of the several books into which the volume is divided. We notice a few practical mistakes which, however, are excusable, the author's experience being,

we imagine, entirely in the domain of theory; thus, for example, it is stated that the zinc coating on telegraph wires is laid on by electrolysis, a supposition which may have arisen from the absurd name "galvanising" which has been given to the actual process. On the page relating to telegraph apparatus, also, it is stated that "there is usually an electric bell at each station to call the attention of the clerk when a message is to be sent"; it is, perhaps, almost unnecessary to say that the use of bells has been abandoned for more than 30 years, the "click" of the instrument being all the alarum that is required in practice.

NOTES.

Viscount Bury's Electric Lighting Act Amendment Bill—This Bill, which was introduced in the House of Lords last week, is a short one, and provides for the purchase of an undertaking after 42 years. The main clause of the Bill is as follows:—Section 27 of the principal Act is hereby repealed, and in lieu thereof the following provisions shall have effect, that is to say, "Where any undertakers are authorised by a Provisional Order or special Act to supply electricity within any area, any local authority within whose jurisdiction such area or any part thereof is situated may, within six months after the expiration of a period of 41 years from the date of the passing of the Act confirming such provisional order, or of such special Act, and within six months after the expiration of every subsequent period of seven years, by notice in writing require such undertakers to sell, and thereupon such undertakers shall sell to them their undertaking, or so much of the same as is within such jurisdiction, upon terms of paying the then value thereof as a going concern. Such value in case of difference shall be determined by arbitration, and due regard shall be had to the nature and then condition of the buildings, works, materials, and plant of the undertakers, and to the state of repair thereof, and the suitability of the same to the purposes of the undertaking, and where a part only of the undertaking is purchased, to any loss occasioned by severance. The Board of Trade may determine any other questions which may arise in relation to such purchase, and may fix the date from which such purchase is to take effect, and from and after the date so fixed, or such other date as may be agreed upon between the parties, all lands, buildings, works, materials, and plant so purchased as aforesaid shall vest in the local authority which has made the purchase, freed from any debts, mortgages, or similar obligations of such undertakers, or attaching to the undertaking, and the powers of such undertakers in relation to the supply of electricity under this Act or such provisional order or special Act as aforesaid, within such area or part thereof as aforesaid, shall absolutely cease and determine, and shall vest in the local authority aforesaid."

The Electric Light at the Law Courts.—The following is not at all a pleasant story of what sometimes happens at the Law Courts; a want of proper management, one would think, is the cause of the calamitous state of things referred to. A daily paper one day this week said:—"On Saturday the dangerous character of the mode adopted at the Royal Courts of Justice of fixing the pear-shaped vacuum glasses enclosing the incandescent electric lights was brought to the notice of the Vice-Chancellor, Sir James Bacon. Occasionally one of the glasses, all of which taper at the bottom to a sharp point, falls to the ground without the least warning, and it is generally smashed to atoms, to the no small consternation of those who happen to be near. On Saturday morning two of them fell in the Vice-Chancellor's court, one of them alighting on the wig of a learned counsel and the other on the unprotected head of a shorthand writer. The Vice-Chancellor therefore sent for the electrical engineer, and on his attending informed him of what had taken place. His lordship, after hearing an explanation, said he thought that the engineer's own statement showed he was to blame, and if any mischief was done it would be laid at his door. The matter required immediate attention, and the occurrence ought not to happen again. Before leaving, the engineer, at the Vice-Chancellor's request, examined most of the vacuum glasses in court, and removed no less than five, which he found to be loose."

Electric Light on a Pleasure Yacht.—The well-known cutter yacht, *Kremhilda*, Mr. A. C. Boothby, which is about to proceed on a cruise to the Mediterranean, has been recently fitted by Messrs. Siemens Brothers with the electric light, this work having been carried out on a most extensive scale. A Brotherhood's engine combined with a dynamo is fitted on deck for the purpose of generating the electricity for charging accumulators. The engine is driven from the boiler of a steam launch, which the yacht will carry, and two hours' running of the dynamo will generate and store sufficient electricity for a week's lighting.

Maxim-Weston Electric Company, Limited.—We are informed that this company has just completed the lighting of the extensive new flour mills at Newcastle, the property of Messrs. Robert Hedley & Co. The following is their account of the installation:—"Our lights are all 20 C.P. lights, which are suspended from the joists some 10 to 15 inches, and usually are so placed in clear positions as to light a space equal to 15 feet by 15 feet. On the roller floor the lamps are numerous, a good light being required in this department, and are placed in a line as far as possible and between the different lines of roller mills, and thus securing a full diffusion of the light. The distance apart varies from 10 to 16 feet according to the placing of the machine. On the centrifugal and reel floors they are placed between every two machines, admission being thus obtained from one side or the other to all machines, whilst the portable hand lamps supplied to us by your company, according to specification, enable an examination to be made into the interior of any machine with safety. In warehouses one 20 C.P. lamp to a space of 15 feet by 30 feet will be found sufficient. Generally the light keeps the interior of the mill cool. We adopted the light after a careful calculation of comparative cost of gas and electricity."

Mr. Preece and Domestic Electric Lighting.—A gas journal has been making merry at Mr. Preece's expense, delivering itself as follows:—"Mr. Preece, the high priest of domestic electric lighting, met a large audience at the Society of Arts rooms, on Wednesday night, and succeeded in keeping that audience in wonderfully good humour for the space of an hour and a half with the expenditure, on his part, of a few vague generalities, dispensed in half humorous, half cynical manner. Although Mr. Preece abstained from saying anything about his daughter's dolls house, he provided charming substitutes in the shape of a cigarette-lighter and an arrangement of electric lamp to enable ladies to do up their back hair. These advances in the science of domestic lighting will, no doubt, be admitted by all to be sufficient evidence of Mr. Preece's originality. The paper is amusing if not instructive, for the only definite feature in it is that the lighting of Mr. Preece's house now costs just double what it did when he used gas, even although he had to pay 4s. 9d. per thousand cubic feet for the gas. But the benefit to health! Who can estimate it? Mr. Preece has quite made up his mind that by adopting the electric light he has made an appreciable addition to the allotted span."

Railway Stations as Telephone Exchanges.—The United Telephone Company has made arrangements, according to one of its officials, with three of the great railway companies, to turn all the stations of the latter into telephone exchanges.

Opening of a Telephone Exchange at Bournemouth.—The formal opening of the newly-established telephone exchange at Bournemouth took place a few days since at the local headquarters, and in the course of the proceedings Mr. H. F. Lewis, general manager of the Western Counties and South Wales Telephone Company, stated that they had at the present 41 exchange orders and four private line orders. With regard to Poole, he had hoped that they would have been able to have opened that day, but the prolongation of negociations respecting existing wires had rendered this impossible. By the middle of April, however, he trusted that the exchange between Poole and Bournemouth would be open. Later on, if it could be profitably worked, there might be connections with Portsmouth, Weymouth, and other places, but of course this would be for the future, as it would involve an expensive outlay. He pointed out that at Bournemouth they had the most favourable rate that was charged in the United Kingdom. With regard to all night communication, he promised that as soon as they reached 150 subscribers it should be conceded to them free of cost. On Sundays the exchange would be opened until nine o'clock in the morning. Mr. J. Druitt then opened the exchange, which was tested and pronounced to be thoroughly satisfactory. A discussion subsequently took place, in the course of which it was promised that as soon as 100 subscribers were obtained the exchange should remain open until 11 o'clock at night. The company afterwards adjourned to the switch room where the working of the exchange was explained to them and a vote of thanks was accorded Mr. Lewis for the invitation.

The ss. "Buccaneer."—We learn that the ss. *Buccaneer*, which has been employed in making an exhaustive survey of the soundings along the West Coast of Africa, is expected in England very shortly. In carrying out her work, which is preparatory to the laying of the cables manufactured by the Silvertown Company, this steamer has gone as far as St. Paul de Loando, and has, we hear, gathered most interesting and useful information during her voyage.

Personal.—We are informed that Mr. J. S. Raworth, formerly agent to Messrs. Siemens Bros. & Co., has been appointed Superintending Engineer to the Anglo-American Brush Electric Light Corporation, Limited.

Society of Telegraph-Engineers and Electricians.—The next meeting at 25, Great George Street, S.W., will take place on Thursday, April 8th, 1886, at 8 p.m., when the discussion on "Electric Lighting by means of Low Resistance Glow Lamps," by Alexander Bernstein, will be continued.

At the last meeting of this society the secretary announced that on the 8th, 13th and 15th of April the Lumleian lectures at the Royal College of Physicians, Pall Mall, would be delivered by Dr. Stone, the subject being "Man as a Conductor and Electrolyte," and that members of the society could, on application to the secretary of the latter, obtain free tickets for the course.

Inclines on Tramlines.—We do not consider it an easy task to set an electrically-propelled car to start with its full complement of passengers up an incline of 1 in 17, and we should be glad to know whether such a condition is ever met with in actual practical operations with either horse or steam traction. Are cars ever allowed to stop at such points as would involve the above condition?

Electric Light and Telephone Wires.—We have had brought to our notice some specimens of electric light leads and telephone cables recently brought out by Mr. W. T. Glover. We are of the opinion that there will be some demand for these new conductors, which are specially devised for purposes which Mr. Glover will doubtless explain to any applicant.

Electricity as a Motive Power.—The North Metropolitan Tramways Company notifies its intention of applying to Parliament in the present session, by petition, for leave to insert in its No. 1 Bill, now pending in the House of Commons, a clause or clauses authorising the company to use electricity as a power for moving carriages on portions of the existing or authorised tramways in West Ham, East Ham, and Leyton.

The Electric Locomotive and Power Company informs us that it has two engines finished and six others building for the North Metropolitan Tramways Company's traffic. The company has also at Stratford charging plant consisting of a 25 H.P. Marshall's engine and two Phœnix dynamos, each of 180 volts and 160 ampères—ample power for keeping charged six engines for 15 hours per day. At the factory at Homerton between 70 and 80 hands are employed principally in constructing a new accumulator (the invention of Mr. Elieson) for the engines. The board of directors has been strengthened, the Earl of Galloway being now the chairman, and all (save Mr. Elieson) have subscribed for £2,000 of shares.

The Glasgow Athenæum New Buildings.—The committee contemplate the adoption of the electric light throughout these buildings.

Sporting Query.—A sporting friend asks us for information respecting the Moseley Harriers. We can only reply that we believe the club is composed solely of members on the staff of a new Manchester periodical, but we cannot guarantee that this is correct.

The Blackpool Electric Tramcars.—We are informed that a number of cars are now regularly in operation and that Mr. Holroyd Smith's system is considered eminently satisfactory. We are pleased to learn this, and hope soon to hear that Mr. Smith is pushing his way in other directions. The time is not far distant when electrical propulsion on short lines will become a great industry.

Crossley v. Littleton.—Many of our readers will peruse with an unsual degree of interest the report of this action which appears in our other columns. Mr. Littleton has at various times contributed to our correspondence columns and his electric lighting installation at Sydenham has already been described by us. We have somewhat freely commented upon this case in the interests of domestic electric lighting generally, and we hope that Mr. Littleton's experience is an exceptional one. The following is the guarantee given by Messrs. Crossley with their engines:—"We undertake to repair or replace any parts of these engines which may be broken or suffer from undue wear within six months after date of delivery, unless such wear or breakage is caused by careless or improper treatment."

The Paddington Installation.—Is there any truth in the rumour that the electric lighting undertaking at Paddington Station is about to be abandoned? We are only too much afraid that the only answer will be, "'Tis true, 'tis true, 'tis pity; pity 'tis, 'tis true!"

The Diaphragm and Tension Regulator.—If we take an early form of Bell telephone with an electro-magnet in place of a permanent one, the diaphragm of the apparatus regulates the current. Could not this in legal phraseology be declared a combination of a diaphragm and a tension regulator? If so, Edison's specification is antedated.

Correspondent's Address Wanted.—If Mr. R. Mitchell will send us his address we will forward to him a set of circulars respecting the Khotinsky battery, left with us for the purpose. A letter directed to Mr. Mitchell at Walham Green, S.W., has been returned as insufficiently addressed.

The Edison Telephone Transmitter.—In the judgment delivered in the case of the U. T. Company *v.* Bassano, Mr. Justice North says :—"It was also known that by the use of the electric current certain sounds, such as musical notes, could be transmitted to considerable distances, *but no mode by which articulate speech could be reproduced at long distances had yet been worked out.*" The italics are our own. Quoting from Mr. Edison's specification the learned judge proceeded :—"This invention relates to *that class of electrical instruments* in which sound becomes one of the elements in the transmission of the communication and a corresponding sound is produced at the receiving station, so that *oral communication can be sent by electricity*, and clearly distinguished at the receiving station." The italics are again our own. Does not this show, Mr. Justice North to the contrary notwithstanding, that Mr. Edison was aware that articulate speech had been reproduced, or why should he be careful to speak of his invention as belonging to *that class* of electrical instruments, &c. ? What says "the man who laughs" to this plum ?

Improved Battery Cells.—The illustration represents one of the patent insulated Leclanché cells of Messrs. Gent and Co., to which we alluded last week. As may be seen, the projecting edge of the glass jar is formed with a gutter or groove, in which is placed an insulating material very much resembling vaseline. The

lead tops to the carbons, which are usually found in other forms, are, as we have previously stated, done away with, the terminal being embedded in the carbon itself. We have some recollection of a similar form of glass jar having been used by Mr. Sellon for secondary batteries.

The Tours Central Station Installation.—The secretary of the National Company for the Distribution of Electricity by Secondary Generators has written stating that we did not intimate that the electric lighting installation at Tours which we described last week was carried out on the Gaulard and Gibbs system, the patents for which the company named holds. A more careful perusal of our article will doubtless reveal the fact to Mr. Pickering that he was mistaken.

Electrical Con.—Why should an electrical tramcar worked by secondary cells be the most economical ? Because it dispenses with the usual conductor.

Electricity in the Royal Navy.—During last week trials of electric lighting apparatus took place on board the barbette ship *Collingwood*, at Portsmouth, which has just been turned out of hand by Messrs. Siemens. The whole of the lamps were tested, and some excellent results were obtained, the light being all that could be desired. The torpedo ram *Polyphemus* has been ordered to proceed to Devonport in order that the Signal Committee may have an opportunity of witnessing a trial of the electric night semaphore which has been fitted on board that ship.

Australian Papers please Copy.—The following extracts, when read together, may prove interesting to those who have anticipated the benefit of the reduction of the tariffs, due to the late Telegraphic Conference at Berlin.

"I have received the following letter from a correspondent signing himself 'A Yachtsman':—'Dear *Truth*,—I am fortunate enough in having inherited some money from my father, which I have invested in various ways. Being passionately fond of yachting, I have, for one thing, bought a yacht, in which I am now cruising in the Mediterranean. The other day we came across a splendid vessel, beautifully fitted, with a gay company on board, and all the indications of a very wealthy owner. I said to my friends: "I should not like to have to pay for the fitting up and expenses of that yacht." On inquiry, I found that the vessel was the *Electra*, and I further discovered, to my intense surprise, that Mr. John Pender, the telegraph magnate, was yachting in her. As some of my investments have been made in the Eastern Telegraph Company, I find I am actually helping towards paying the expenses of that gentleman's yachting excursion, the *Electra* being one of the steamers of the company. I fancy you will be interested in this little game, and so I send you word.'"—*Truth*, March 11th.

"Egyptian news.—The Government have declined to confirm the provisional arrangement proposed by Mr. Floyer at the Berlin Telegraphic Conference. The Eastern Company's position is, therefore, precisely the same as before."—*Daily News*, March 19th.

"Exchange Company's Telegraph, Alexandria, Friday, 5.45 p.m. Mr. Pender having completed his inspection of the Eastern Telegraph Company's stations at Alexandria, Cairo, Port Said and Suez, and also the cable which has been laid along the canal for the company's use, proceeds to Malta on board the company's repairing steamer *Electra*. During his stay at Cairo, Mr. Pender has completed negociations with the Egyptian Government, which will be of great benefit to the Eastern Company and the public using that system. It is proposed shortly to reduce the tariff for press messages from Egypt".—*Exchange Slip*, March 19th, 1886."

The Spiel Petroleum Engine.—Dr. Hopkinson, F.R.S., has given a report on this new motor based upon his tests made therewith. He does not state the price of the oil when bought in large quantities, and therefore the cost of working, which he calculates at 1½d. per H.P. hour, with the addition of say ¼d. per hour for lubrication, appears to us open to doubt. By this is meant that we are inclined to the belief that Dr. Hopkinson's figures are in reality too high, not under the mark. From our own observations on this engine and some considerable experience of another of similar construction, we can cordially endorse all that Messrs. Hopkinson and Appleby state in favour of this method of obtaining motive power. We wish the company, just formed for the purchase of the Spiel patents, every good fortune, for if successful the company's operations would be a means of lessening to some extent the injurious effects of the monopoly in gas-engines, although we should not be at all surprised if a legal suit is brought about by the proprietors of the Otto engine. There is, however, one point which we do not see mentioned. Is it likely that any difficulties will arise, for instance with insurance companies, touching the dangerous properties of the oil ?

The Etéve Engine.—What has become of the Etéve petroleum engine ? We had expected ere this to have seen it ready to place on the market. The prospects of many a good apparatus appear at times to be temporarily, if not permanently, blighted, by the inertness of those into whose hands they may happen to fall. We trust that this is not a case in point.

Portable Electric Hand Lamps.—The dimensions of the lamp illustrated in our last week's issue are 5½ by 4½ by 3½ inches, its weight 6¾ lbs. This is the lamp to which Mr. W. H. Preece referred the other day in his paper on "Domestic Electric Lighting."

Admiralty Survey.—We are informed that H.M.S. *Sylvia*, a surveying vessel under the command of Captain Dawson, is now engaged on the Guinea Coast in checking and correcting previous work. The French man-of-war *Inferente* is also doing similar work. Both of these vessels have taken advantage of the recently laid cables to get time-signals, the lines having been placed at their disposition by the West African Telegraph Company.

"Substantially as Described."—Is there any meaning attached to the words above with which claims in patent specifications usually end? Mr. Justice North states that Edison's claim is for "the combination of a tension regulator with a 'diaphragm or tympan,' not confining it to any special form, and I have heard no complaint that the claim is too large in this respect." There is, however, a qualifying phrase, "substantially as described." Does a claim embrace everything which is not described or even thought of at the time of the invention?

The Government and Electric Lighting.—It is refreshing to note that at last a "Liberal" Government has admitted that there is some cause of complaint in the conditions of the Electric Lighting Act of 1882. Lord Houghton's remarks last week were a distinct advance of position on the part of the Government, but something further than that which he promises for the Government Bill is required.

Reform in the French Telegraph Department.—Just before going to Press we received a notification that the following engineers have been appointed chief inspectors, and form the council which will have the direction of telegraph work :—

M. Raymond,	formerly chief of the	Eastern district	of Paris.
„ Loir,	„	„ Lyon	„
„ Berger,	„	„ Tours	„
„ Belz,	„	„ Marseilles	„
„ Berthot,	„	„ Lille	„
„ Mazne,	„	Inspector of Comptrol at	Paris.

MM. Balavoine and Berthelin have been appointed divisional chiefs. They were formerly Inspectors of Comptrol.

Fastnet Light Cable.—The *Medina* left Gravesend last Tuesday to repair this cable.

Société Internationale des Electricians.—Owing to the great increase in the number of members of the International Society of Electricians residing in England, the council of the society has decided that it would greatly facilitate the society's business with those members if it had an official representative in this country, and have accordingly appointed one of their members, Mr. R. Aylmer, M.I.C.E., A.S.T.E., of 42, Parliament Street, S.W., as Hon. Secretary and Treasurer for Great Britain.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Parker's Electric Wire Corporation, Limited.—The first return of this company made up to the 22nd ult. was filed on the 29th ult. The nominal capital is £100,000 in £5 shares; 7,500 shares have been issued as fully paid, and 107 ordinary shares have been taken up. Upon the latter £4 10s. per share has been called, the calls paid amounting to £432 leaving £49 10s. unpaid. Registered office, Palace Chambers, 9, Bridge Street, Westminster.

CITY NOTES, REPORTS, MEETINGS, &c.

The Electrical Power Storage Company, Limited.

THE adjourned fourth ordinary general meeting was held at the Cannon Street Hotel, on Thursday, the 25th March, Sir Daniel Cooper, Bart., in the chair.

Mr. H. Dell, the secretary, having read the notice convening the meeting, the directors' report, which was published in the REVIEW last week, was taken as read.

The Chairman then said: Gentlemen, I consider the most convenient method of transacting the business before us will be to deal with the years 1884-5 at the same time—the discussion must include both years, and my remarks will therefore cover the same period. At the conclusion of the adjourned meeting the fifth ordinary general meeting will be held. The report deals fully with all the points of interest to the shareholders, and I now propose to make some observations upon it and the statement of accounts. You will have gathered from the report that the business of the company has rapidly increased, a marked improvement having taken place during the latter half of 1885, and the prospects for the current year are extremely encouraging. In accordance with the articles of association the accounts of 1884 have been opened for inspection at the offices of the company, and the balances therefrom have been carried forward to the accounts of 1885. You are aware that a heavy loss was made in 1884, but the result of a complete change of management is that in 1885 we have made a profit upon manufacture, and are now also receiving cash remittances from the realisation of our patent interests abroad. We propose to spread the suspense account of 1884—£9,848 19s. 10d. over the next five years, as we consider this amount was not fairly attributable to 1884, but to 1883 as well. The year 1885 shows a gross manufacturing profit of £10,902 17s. 10d. I think you will agree with me that these figures are most satisfactory considering the adverse circumstances we have had to struggle against. We undertook to greatly reduce the expenditure; we have done so, and have at the same time secured thorough efficiency. The net result is that the profit and loss account for the year 1885 exhibits a profit of £2,200 9s. 2d. The past two years has been a period of great anxiety to the directors, and we have all given unremitting attention to the affairs of the company. I would point out that we have not taken any fees, but we intend, with your approval, to take them in future. You see from the balance sheet that, when the shareholders did not come forward sufficiently to support the company, the directors provided the cash with which the present satisfactory position has been attained. The Millwall works are large and amply sufficient for an increased output, and a slight strengthening of the staff, as at present organised, would suffice for this purpose. The manner in which the electrical and engineering work entrusted to the company has been carried out by our engineer (Mr. Drake), the works manager, and the staff, has met with general approval, and a reputation for thorough workmanship has been acquired which has placed the company in the first rank of electrical contractors. In proof of this I would mention two of the latest installations carried out in London, viz., the Bank of New South Wales and Lloyds, as examples of the company's work, which are readily accessible to those desirous of being convinced as to the efficiency of its installation work. A third installation, that for 1,500 lights at the Prudential Assurance Company, is not yet completed, but will, when finished, I do not hesitate to say, stand pre-eminent for magnitude and quality among the electric light installations of this or any other country. The company is now extending the field of its operations, as for example, the lighting of the Folkestone Exhibition, the contract for which has been given to us on satisfactory terms. As a frequent visitor and well-wisher to the town of Folkestone, I am very desirous for the success of this exhibition, and I have no doubt that our staff will make a perfect success of the electric lighting there. We have also contracted to furnish a large number of lights, about 1,000, for the forthcoming Colonial Exhibition, in which I, of course, take a deep interest. The batteries have for some time past given every satisfaction to purchasers, and have been adopted by all the large electrical companies and firms, and by many private gentlemen for their residences. Among these may be mentioned Sir William Thomson, Sir W. Armstrong, Mr. Harben, Mr. Littleton, Mr. Fred. Green, Sir David Salomons, Lord Thurlow, and many others. The directors have personally brought to bear what interest they possess in getting orders for the company, and several installations have already been the result, and they ask the shareholders to assist in the same way with their friends in the lighting of private houses, banks and companies, where their influence may be of much service. In temporary lighting for balls, evening parties, &c., the company is doing good business. Among them, the lighting of Marlborough House for H.R.H. the Prince of Wales, Grosvenor House and Eaton Hall, for his Grace the Duke of Westminster, may be specially mentioned. In the propulsion of boats and tramcars large progress has been made during the past year, and we may expect the progress to continue. On the Continent electrical tramcars are used, as at Berlin and Antwerp, and are having more attention than even in this country, and as regards the propulsion of boats we look for more orders for this class of work from the successful running of the Duke of Bedford's electric launch. A considerable extension of train lighting can also be expected during the current year. The London, Brighton, and South Coast and the South Eastern Railways are determined to meet the wishes of the public for the electric lighting of railway carriages, and other companies have the matter under consideration. In regard to the long continued negociations in the United States, to which I alluded at previous meetings, it is with much satisfaction I have to announce that they have been brought to a successful issue. It gave the directors great pleasure to welcome to England the American gentlemen who, with their electrical staff, have just returned to their own country, after a most thorough study of the methods of manufacture of batteries at Millwall and the installations erected by this company. They are the gentlemen to whom reference is made in the report as

having recently associated themselves with the New York Electrical Accumulator Company, in which we have a large interest as shareholders, and who by energy and skill in management have already achieved a brilliant success in America in another direction. Mr. Theo. N. Vail, so well known in the States in connection with the American Bell Telephone Company, has accepted the post of President of the New York Electrical Accumulator Company. The outlay in the United States has been necessarily large, but we believe that we shall be now amply repaid. Regarding the foreign business I have nothing to add to what is stated in the report. We are pushing the business and selling the batteries direct throughout the Continent. The suit in Germany relates to a lien alleged to exist against the Faure German patent before it was transferred to this company, and this claim, therefore, affects the payment of the German royalties. I cannot avoid referring to the injury inflicted upon our business by the Electric Lighting Act of 1882, and I rejoice to see that there is hope of its amendment during the present session of Parliament, but we must not relax our efforts for an alteration of some of its most obnoxious clauses. The Bill brought in by Lord Rayleigh in the House of Lords deserves our warmest support. We have to regret the death of our colleague, Mr. William Ladd, which occurred last autumn. I think I have now touched upon most of the points in the report, but we shall be happy to give any further information that may be desired. I may just add, in conclusion, that this is really the meeting for 1884. We merely ask you to approve of this report and statement of accounts and then pass into the 1885 meeting. To do otherwise would be to stop discussion upon 1884 matters, and we think it best to keep the whole open for discussion. I beg to move that the report and statement of accounts now submitted to the meeting be received and adopted.

Mr. J. S. Sellon said: I beg to second the resolution put before you by the Chairman, and in so doing it is of course a great pleasure to be able to say that my long since recorded conviction seems now about to be justified by events—namely, that to this company, if wisely directed, honestly conducted and efficiently managed, will be assigned the foremost position of all the important undertakings connected with electrical industry. When domestic lighting was first initiated, apparently insuperable difficulties supervened, namely, non-existence of any means by which a continuous supply of light could be ensured unless the motive and the generating power were in motion, that is to say, unless the engine and the dynamo were working continuously; and even under such inconvenient and difficult conditions the disadvantages of an unsteady and flickering light, the frequent destruction of lamps and accidental breakdowns were unavoidable. It was this intolerable state of things which made the introduction of a storage system absolutely necessary, and we all know how, in spite of enormous difficulties it has made its way, how the scientific and practical electricians of the present day recognise that no isolated installation is complete or perfect without it. This being so, let us consider our present position: confidence is established in our manufacture, and we all know that progress is making way with rapid strides in the electric light industry. The absolute necessity of a storage system is, as I have said, generally recognised. Experience has been gained, fortunately, during a period when but a limited amount of work could in any case have been possible, and you have as your property intact patents which command the whole field in this branch of industrial work, to which, I think, no limit can be assigned. You have also a competent managing director who devotes his time and energy to your service; under him you have an efficient and trustworthy staff, and I would venture to suggest that you also have a board of directors who spare no efforts to advance and secure your interests. Under these circumstances, it is scarcely difficult to forecast what the future of this company should and will be. If you have such conditions as good management and the control of certainly one of the most important factors in connection with the rising industry of the age, I think, however high our hopes have at any time been raised, they will in the end be fully justified. I will ask you to adopt the report and statement of accounts put before you by the chairman.

A Shareholder remarked that there was one question he would like to ask, whether they might have the report of the auditors before they were asked to pass the accounts. The report of the auditors was, or should be, common to the shareholders.

Mr. Courtenay, the managing director, read the auditors' report, a lengthy document, wherein matters relating to the accounts were elaborately explained. It pointed out that the accounts could not be certified as correct, because an error had been discovered of £6 8s., which there had not been sufficient time to trace to its source.

The Chairman said they thought it better to go on with that meeting rather than delay a fortnight or three weeks, after having sent out the notices, in order to go all through the accounts again to discover the £6 8s. He gave them his undertaking that at the next meeting it should be reported whether the mistake had been traced or not, for they should not allow it to go over.

The Chairman: We now resolve ourselves into the meeting for 1885. It is a source of great pleasure to me to get rid of our previous history up to the end of 1884. If in future we do not have very rosy accounts, I hope at all events we shall have very satisfactory ones, showing profitable business. I move that the accounts of 1885 be adopted.

Mr. Sellon seconded the motion, which was carried.

The Chairman proposed the re-election of the vice-chairman (Mr. J. S. Sellon) and of Mr. J. Irving Courtenay, the managing director. In regard to Mr. Sellon he need hardly say that his knowledge and experience were of great importance to the company. Mr. Courtenay was now their managing director. It was not usual for a managing director to be put up for re-election, and it might be advisable at a future meeting to alter the articles in that respect. Mr. Courtenay had resigned the directorship of another electrical company so as to give more time to the business of this company, and they had been fortunate in securing his services for the term of three years.

Mr. A. L. Noel seconded this resolution, which was carried unanimously.

Mr. Courtenay thanked the shareholders for his re-election, and then read the testimonial of Sir William Thomson to the excellence of the company's secondary batteries, which testimonial appeared in the Correspondence columns of the REVIEW last week

Mr. G. Cawston called attention to the balance sheet, in which the balance of trading account was shown to be £10,900; on the other side of the accounts £3,800 were set down for the expenses at Millwall, there being thus shown a net profit of £7,000 on the trading account. The large sum of £2,500 appeared for expenses in London, and this seemed to him a most extraordinary amount, seeing that the work was all done at Millwall. The actual profit on the concern was by means of these and other expenses brought down to £2,200. He wished, also, to call attention to the matter of the royalties, which had only brought them in £130, whereas they had paid out £1,000 in law expenses and patent fees. He thought the net profit ridiculously small compared with the large amount of work carried on at Millwall.

Mr. Courtenay said if the expenses of the head office were, as Mr. Cawston asserted, very high, he could only say that they were a great deal lower than they had ever been before. He had no hesitation in saying that if Mr. Causton went through the items of the expenditure in connection with that office, he would see that it was worked more economically than most offices in London. It must be remembered that the engineer's and other salaries went against the head office. With regard to the law expenses, they had had two heavy law suits, one in which they were sued by their former works manager for summary dismissal. The other was the Elwell-Parker suit, which was satisfactorily settled by Elwell-Parker agreeing to pay them royalties. There were, of course, no royalties from them in this account; they would come into the accounts for next year. The royalties in the accounts were foreign royalties. Then there was the further question of the other law charges. If they did not think fit to protect their patents in this country and abroad they might as well retire from business; because people were not going to pay them the price of a patented article for that which any other person might manufacture. The directors would proceed against anyone infringing their patents; they were bound to protect their property, and just recently, by protecting their property, they had been able to earn solid profits. He hoped the expenses would not be so heavy in future—he did not think they would be. There was a dispute in Germany about the title of one of their patents, and they were receiving no royalties pending the issue of the suit. They were advised that they had a good case, and they proposed to press for payment of the royalties. Then, again, in America, they had satisfactorily settled matters there; the interest they had in New York was most valuable property. They had had very heavy expenses there, but it would all come back, and, what was more, it was coming back. He was much mistaken if, before the end of the year, they did not receive a great deal more money from abroad than they paid out, and for those very patents they were now defending: that was to say, the outlay for this year would be much less than the cash they would receive. But they could not expect to get anything if they did not defend their property. The directors were just as much for peace as was Mr. Causton, but when it came to war they were determined to protect the company, and in this he hoped the shareholders would stand by them.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., were then re-appointed, after which

Mr. Schiff, after applauding the general conduct of the directors, making special reference to their praiseworthy reticence regarding matters better not publicly discussed, said what fell from the Chairman with regard to the future was very satisfactory, and he believed he was only doing his duty if he emphasised the words with which he (the Chairman) had referred to the engineering department of the company, which formed a very necessary part of the concern. He proposed a vote of thanks to Mr. Drake, the engineer, Mr. Gorham and the staff of the company.

General Penney seconded the motion, which was unanimously accorded.

Mr. Cawston moved a vote of thanks to the Chairman and directors, which was seconded by Mr. Noel, and agreed to amidst acclamation.

The Chairman, in replying, said the company had the very best of the directors' time. Things were much more cheering now, especially when they met with the approval of the shareholders in what they had done. He (the Chairman) was quite certain, as month by month passed, they would attain a solid and satisfactory position; and it was the encouragment they now got from the shareholders and the public, that cheered them on. The engineers wished and were encouraged to do all the work in as perfect a manner as possible, and not to go in for a large quantity of work and do it in an indifferent manner, which would only cause a want of confidence; but, he might say, that if the Act of 1882 were altered,

which it must be, for it was perfectly unworkable, they hoped to very largely increase the working of the company, without increasing largely the expenses.

The meeting then terminated.

Western Counties and South Wales Telephone Company.

THE first annual ordinary general meeting of this company was held on March 25th, at the Grand Hotel, Broad Street, Bristol, Mr. Chas. Nash, chairman of the Board of Directors, presiding. There was a very limited attendance of shareholders.

Mr. H. F. Lewis, general manager and secretary, having read the notice convening the meeting, the report, which had been printed and circulated amongst the shareholders, was taken as read.

The Chairman, in moving that the report and audited accounts be adopted, observed that though that was the first annual meeting of their local telephone company, the accounts comprised 16 months' work, that was to say, from the 1st of September, 1884, to the 31st of December, 1885. The date of holding the meeting was somewhat later than intended, some delay having arisen in consequence of the accounts being a little complicated at first. He hoped that on the whole the shareholders would consider that the result of the working had been satisfactory. He was not going to dwell on the figures, for he thought that the accounts put them very clearly, and scarcely required any explanation. Great care had been taken to charge the revenue with everything applicable to revenue, and that point was particularly noticed by the auditors, who spoke favourably on it, and in the way the stock account was kept. Mr. Lewis was, in fact, complimented on the stock account being kept in a more complete way than almost any others which the auditors had met with in their experience. One-fifth of the preliminary expenses, and one-tenth of the cost of the furniture had been written off, and they proposed to begin a reserve fund against depreciation of plant by setting aside £500. So much for the accounts, and turning to the future he thought they might all of them be reminded that the telephone in this country was quite in its infancy. In England they had about 32,000 telephones, whereas in America there were 325,000. Some people imagined that the great spread in America was because the rates were lower, but in New York the rate appeared to be £30 and upwards, whilst in Bristol it was £15, and the highest rate in Great Britain was £20 a year. In most of the large towns in America the charge was £25, but in New York alone there were more telephones than in the whole of the United Kingdom. He thought they might fairly assume that gradually, and perhaps rapidly, the telephone would increase in use in their own country. In Bristol there had been a steady progress, and if they looked at other places in their district they found that Plymouth and Torquay were likely to afford a considerable increase in their business. They had opened an exchange at Bournemouth, which had commenced in a most satisfactory manner. At once there were about fifty subscribers, and they looked forward confidently to having at least 100. Mr. Lewis, the secretary, was present, and looking over the report of the proceedings he (the chairman) observed that they looked upon him there almost as a public benefactor. They were preparing to open exchanges at Bath, Gloucester, Sharpness, Weston-super-Mare, Worcester, Malvern, and many other places, but perhaps the most important part of their district was South Wales. Trunk lines were to be established—were, in fact, in progress between Bristol, Cardiff, Newport, Swansea, and Llanelly, and the chairman pointed out that by an extension from Cardiff to Pontypool, and to the Rhondda Valley, Aberdare, and Merthyr, they hoped to have a network of wires to the various works and collieries in the neighbourhood. The chairman said he would like to remind their friends of the great extent of district that the Western Counties and South Wales Telephone Company possessed. Looking at the extent of surface, it was more than one-fourth of the whole of England and Wales. It was true there were not many large and populous towns, but there were a great many towns where they might look forward to a considerable telephone business. In Cornwall, he believed that the mining centre about Camborne was likely before very long to be an important telephone district for them. (Hear.) He observed that free communication had been given to their charitable institutions, and a few days ago Mr. Cave, the president of the infirmary, mentioned how thankful the staff felt that telephonic communication with the infirmary had been given. The advantage of the telephone system in case of fire had been proved over and over again, and only on Saturday last its usefulness to the police was shown in the case of a demonstration of the unemployed. Finding out what the route of the procession was likely to be the police were enabled to telephone to the various stations, so that a body of police could be placed on the line of route, and that could not have been done without the telephone. The chairman then formally moved the adoption of the report and accounts, and the declaration of a dividend of 6 per cent. on the paid up preference shares.

Mr. Mark Whitwill seconded the motion, and said, like Mr. Nash, he believed that the use of the telephone was yet in its infancy. It was coming, however, to be regarded as one of the necessities of life, and nothing was likely to check its growth unless it was the obstruction of local authorities.

Mr. J. B. Morgan (of the United Telephone Company) said that as one of the largest preference shareholders it was pleasing to him to observe that that was the first of the companies that had placed a sum to reserve account in the first year of its existence.

The resolution was unanimously adopted.

On the motion of the Chairman, seconded by Mr. H. Fedden, it was resolved that a sum of £500 be placed to a special reserve fund for depreciation of plant.

Mr. Chas. Nash, Mr. Mark Whitwill, Commander Forsyth, R.N., Mr. Henry Fedden, Mr. Thomas Pole, and Mr. Richard Cory were re-elected directors, and Messrs. Tribe, Clarke, and Co. were reappointed auditors.

The Chairman said they had in Mr. Lewis, the secretary and manager, a most valuable officer, and he thought they should not leave without expressing the opinion they entertained of Mr. Lewis's services.

Mr. Morgan seconded the resolution.

The resolution was carried by acclamation.

An extraordinary general meeting was then held for the purpose of making certain alterations in the articles of association, and resolutions approving the same were unanimously adopted.

A vote of thanks was passed to the chairman, and the meeting terminated.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.—This company notifies that the accounts to the 31st of December last show, subject to audit, a profit balance of £164,188. After payment of three interim dividends and a bonus of 2s. per share, and charging £55,062 against revenue during the year on account of cable renewals, &c., the directors propose to pay on the 15th inst. the usual dividend of 2s. 6d. per share, together with a bonus of 2s. per share (both tax free), making a total payment of 7 per cent. for 1885. The balance of £41,625 has been carried to the reserve fund, which now stands at £567,802.

The Globe Telegraph and Trust Company, Limited.—The directors have declared an interim dividend of 3s. per share on the preference shares, less income-tax, and of 1s. 6d. per share on the ordinary shares (income-tax having already been deducted), for the quarter ending April 18.

India Rubber, Gutta Percha, and Telegraph Works Company, Limited.—Application has been made to the Stock Exchange Committee for a settling day and quotation for the recently issued £200,000 four-and-a-half per cent. debentures of this company.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 26th were £2,699, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending March 26th amounted to £2,544.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph Engineers and Electricians.

AN ordinary general meeting of this Society was held on Thursday, March 25th, Professor HUGHES, F.R.S., president, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, a paper on "Electrical Lighting by means of Low Resistance Glow Lamps," was read by Mr. ALEXANDER BERNSTEIN, foreign member.

It is not uncommon in the history of technical science to find that constructions which have at one time been abandoned on account of apparently insurmountable difficulties have after a certain lapse of time, been readopted. The high speed engine, the high pressure boiler, the multiple telegraph system, were known and made long before they were generally applied, because their practical application was impossible until a certain amount of experience had been obtained by means of the low speed steam engine, the low pressure boiler, and the single telegraph system.

In a very similar manner the low resistance glow lamp was known and made more than thirty years ago, but has hitherto been considered impracticable. In the meantime the glow lamp of high resistance has made its way, and has met with considerable success. Now to-night I desire to revive the older type of lamps in a new form produced by means of our present experience, and to show at the same time the way in which these lamps may be made to answer the purpose of electric lighting.

As we have been so often told that the lamp of low resistance is neither practical or economical, I must suppose that most electricians are somewhat prejudiced against it. But prejudices are detrimental to the development of truth, and I must therefore request you to take as impartial a view as possible of the case which I shall lay before you to-night.

High or low resistance of glow lamps is not merely a question of construction of the lamp itself; it is a question of principle which determines the whole system of lighting. The requirements of the dynamo, the sizes of the conductor, and the whole system of arranging the circuit, are entirely dependent upon the lamp which we select. It is therefore not sufficient to compare different types of lamps in regard to their qualities as lamps; it

is quite as essential to consider how the use of these lamps answers the practical purpose of electric lighting. I shall therefore divide my paper into two parts—the first dealing with the lamp itself, the second with the manner of its application.

In speaking of glow lamps, and considering their merits, I shall only take those lamps into consideration in which carbon is brought to a state of incandescence, and emits light by reason of its elevated temperature. Although other substances may be used, experience has shown so far that none of them offer the advantages which are secured by the use of carbon, viz., the possibility of applying a very high degree of temperature. This is very essential, because the highest temperature implies the greatest efficiency; and efficiency, together with durability, are the two qualities which principally determine the merit of an incandescent lamp.

Before proceeding any further, allow me briefly to enumerate the principal parts which constitute an incandescent lamp. These are only four—the glass bulb, the conducting wires (which always consist of platinum as far as they are surrounded by glass), the light-giving carbon, and the connection between the carbon and the wires (generally called the mounts). The simple construction of such a lamp does certainly not indicate that its manufacture is beset with so many difficulties. In order to settle our terminology, I shall further mention that the reciprocal of the number of watts required for every C.P. of light emitted will be called the "strain;" so that the strain is small if the number of watts per candle is comparatively large.

The light which is emitted by incandescent carbon depends only upon its temperature and the amount of its radiating surface; but the energy which is required to maintain this light would be determined—irrespective of the losses which may occur in the lamp, and under the supposition that the state of vacuum and the exterior temperature remain unaltered—by those same two magnitudes alone, if the radiating power of all carbon were alike. It seems to me that this last is not the case. From certain analogies, well known in physical science, we may conclude that a black, sooty carbon will radiate more heat than a carbon of a dense grayish surface raised to the same temperature, and consequently the former will require a larger supply of electric energy to maintain it at the same temperature than the latter. This fact seems entirely borne out by observations made on glow lamps.

Let us now consider the peculiarities of a glow lamp of high resistance, say of 100 volts and 0·6 ampère. I select this lamp because it seems that this is approximately the highest resistance lamp which can be practically applied at the present time. At least, I can see no reason why the complicated expedient of a multiple wire system should be used, if electric lamps can be made reliable when working at a much higher difference of potential and with a corresponding smaller current. As the lamp is only to take 0·6 ampère, the filament must be exceedingly fine in order to become sufficiently heated by this current, and moreover, the filament must be of sufficient length to obtain the necessary amount of light-giving surface. As soon as the current is passed through the filament, the latter is raised to a certain state of incandescence; and we shall therefore have to deal first of all with the effect which heat alone seems to have upon the carbon.

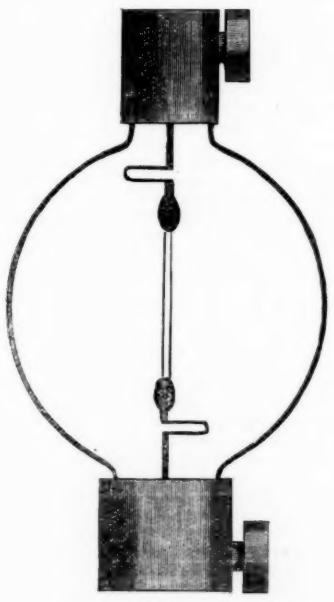

FIG. 1.

Heat has a general tendency to expand all substances; and as it was interesting to know how far carbon is subject to the same law, I have investigated this question by means of a lamp of the following construction:—Two straight filaments are connected by means of a cross piece of platinum in the form of a T, which acts on a lever so arranged as to indicate ten times the elongation of the filaments when these are heated. The annexed sketch (fig. 3), in which A A are the filaments, and B the indicating lever, shows the arrangement which was adopted. The experiment indicated that when the carbon was exposed to a strain of 3 watts per candle, the elongation of the filaments amounted to 120th part of their length. It was further noticed that the rate of expansion was not constant, but increased with the temperature, although at the highest temperatures obtained the coefficient of expansion seemed to decrease again.

The fact that the carbon expands and contracts with every change of temperature explains why lamps with slender filaments are destroyed more quickly when subjected to varying currents than when they are fed by a constant and uniform current, such as that supplied from batteries.

When we look at a heated filament, we notice sometimes that one small spot is brighter than the rest of the filament. This is an indication of a flaw which will sooner or later produce the disintegration of the carbon at this particular spot. These flaws are, for the most part, so minute that they cannot be perceived in the filament when cold, and only gradually show themselves when the lamp is being used. This is one of the causes which produces premature destruction of the lamp. The finer the filament the greater the danger of a flaw.

It has lately been supposed by some writers on the subject that the life of a glow lamp is in direct proportion to the diameter of the filament. Such suppositions, which are mostly made for the sake of obtaining mathematical formulæ, are far too sweeping; and all we are entitled to say is that, *cæteris paribus*, the lamp with a thick filament promises greater durability than the one with a thin filament.

We have before observed that heat produces expansion of the carbon, and from this we may infer that if the heat is sufficiently high, evaporation or disintegration of the carbon would be the result. Such is the case if the carbon is of a soft quality and raised to a very high degree of temperature; but we are fortunately in a position to produce a carbon of such dense and hard structure that there seems to be no perceptible disintegration at the temperature usually employed in incandescent lamps. If we, nevertheless, observe in high-resistance lamps—even if worked at a strain of no more than 4 to 5 watts per candle, and a corresponding low temperature—that the carbon filaments are disintegrated, that the resistance of the lamps consequently increases, and that the glass bulbs begin to blacken, we are led to suppose that other forces must be at work which produce the destruction of the lamp. These forces are of an electrical nature, and their existence is easily explained if we consider that an electric glow lamp is at the same time a vacuum tube.

In the high-resistance lamp we have considered before, there is a difference of potential of 100 volts between the two terminals of this vacuum tube. The fact very soon makes itself apparent in the lamp. If the temperature is sufficiently high, the negative side of the carbon assumes a dark, sooty appearance, and a deposit of black loose carbon is formed on the positive platinum and mount. This action of throwing off particles of carbon from the negative side towards the positive has been the subject of a very interesting paper communicated to the Royal Society by Mr. Preece. The peculiar behaviour of high-resistance filaments is evidently the effect of a combined action of heat and electricity. The heat lessens the attraction of the particles for each other, and the electric forces produce motion. The result is the gradual deterioration and ultimate destruction of the carbon.

It has often been noticed that a blue flame makes its appearance upon the positive platinum when the carbon is raised to a high state of incandescence. As no explanation of the production of this blue flame has as yet been given, I beg leave to insert here a few words respecting the most probable cause of it.

All platinum, when cold, occludes a large quantity of oxygen, which is given off again when the platinum becomes heated. The black, sooty deposit of carbon on the positive platinum is just in a condition to combine readily with the oxygen, and both together form the blue flame. While the lamp is on the vacuum pump this flame may often be seen to travel up and down the platinum wire, always appearing where occluded oxygen is set free. If the pumping continues without the current being increased, the quantity of free oxygen is soon consumed, and the blue flame disappears, but reappears again if the temperature of the platinum is increased by increasing the current. Just in the same manner finished lamps will, under all normal conditions, show no blue flame, but will do so if an excessive current is passed through the lamp. In this case a blue flame is sometimes seen on the negative platinum as well. This occurs because particles of carbon find their way to the negative platinum and are oxidised there in the same manner. As the spectrum of the blue flame has been observed by Messrs. Liveing and Dewar to be that of carbonic oxide, it seems so much the more probable that the explanation here given is correct.

We have now to notice another effect of the vacuum tube. When lamps are made for very high difference of potential and corresponding small current, there seems to be a very strong tendency of the current to leap across from one terminal to another, thereby short-circuiting the lamp, destroying the filament, and fusing the platinum wires. This tendency is very strong when the current is turned on suddenly, as the carbon, being cold, then offers the highest resistance to the passage of the current.

One of the conditions which it is desirable to observe in respect

to a practicable lamp is that a certain excess of current such as is liable to occur in installations must not be able to destroy the lamp; and in this respect it is certain that the lamp with a thick filament is far superior to the lamp with a thin filament.

Turning to another point of practical importance, we notice that lamps with fine filaments are exceedingly subject to flickering as soon as the strength of the current varies but slightly. Variations of this kind may have their cause in irregular motive power, in slipping of a belt, or in a dynamo which is not perfectly balanced either mechanically or electrically. Such flickering will be noticed in a great many installations with small-current lamps, and is exceedingly disagreeable to the eye. Now, with a large hollow carbon used in the lamp which I shall presently describe, the interior is always at a higher temperature than the exterior, and serves as a reservoir of heat which allows for certain variations in the current without any effect on the eyes as regards the light.

How are we, then, to obviate these difficulties appearing in the lamp? If the thin filament does not promise much durability, and is disadvantageous in other points mentioned—if the high difference of potential proves to be a factor in the destruction of the lamp—we must employ thick filaments and a small difference of potential; or, in other words, we must produce a low-resistance lamp.

I think I have sufficiently shown you the right of existence of a low-resistance glow lamp, and I shall now proceed by describing the lamp which is before you, the form of which seems to be one of the best of all the varieties of low-resistance lamps which I have made since 1882.

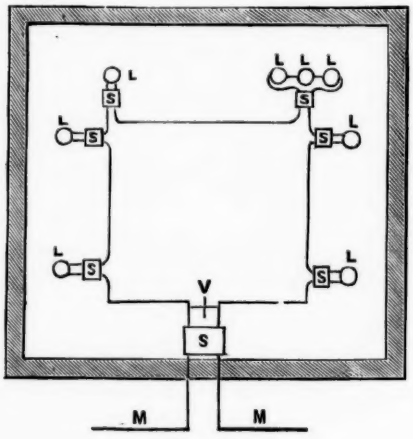

FIG. 2.

The lamp which is shown in figure 1, consists of a glass bulb of oval shape, into the opposite ends of which the platinum wires are sealed. In this manner the glass is placed symmetrically round each wire, and is therefore less liable to crack when heated. The carbon has the form of a straight tube mounted upon short pieces of stout platinum, which are joined to the platinum wires passing through the glass by means of flat thin copper strips, bent upon themselves so as to form springs at right angles to the direction of the carbon. In this way all parts of the lamp can expand and contract without subjecting the carbon to any injurious strain. A cap of insulating material at each end of the glass bulb provides for proper connection with the conducting wires, which may be made to support the lamp; and this connection is made in such a manner as to prevent accidental contact of the manipulator with any part carrying a current.

The success of these lamps depends on the satisfactory construction of every one of its details in an almost equal degree. The quality of the carbon, the way in which the same is mounted, the manner of surrounding the platinum wires with the proper kind of glass, the avoidance of any mechanical strain, and the proper proportion of every part of the lamp, are all the results of tedious experiments, which were necessary in order to produce a satisfactory lamp. The electrical dimensions of the lamp are as follow:—It requires a current of 0·75 ampères, thereby showing a difference of potential of 7 volts, and a hot resistance of about 0·7 ohm.

When speaking of the high-resistance lamp, I have mentioned that there seems to be a limit to the difference of potential which we can apply in each bulb. As regards the low-resistance lamp, there is a limit to the strength of the current of which we can avail ourselves. The difficulty rests with the wires, which have to be sealed air-tight into the glass, as it is far easier to seal in thin than thick wires carrying a large current.

Before concluding this first part of my paper, I shall have to mention one of the drawbacks of the low-resistance lamps, to which Professor Forbes has called attention in his excellent lectures on the distribution of electricity, viz., the loss of heat in the conductors inside the lamp. I quite agree with Professor Forbes that in older types of lamps the loss was very considerable, and a serious question; but in the lamps which I made some years ago this loss amounted to only one-tenth part of the energy consumed. I am happy to inform you that in the lamp before you this loss has been reduced to one-twentieth part of the energy required in the lamp.

I shall now turn to the second part of my paper, and I shall consider it best to attack at once the most difficult problem which can present itself, viz., the supply of a large number of lamps from one central station, with the condition that all the lamps can be used entirely independent of each other, and with the further condition that the expenditure of mechanical energy shall always be proportioned, or, at all events, approximately proportioned, to the number of lights in use. Our imaginary plant is to be arranged for 6,000 lamps, requiring 0·75 ampères, and upon the average 6 volts each. Let us first look into the central station and consider its requirements. We shall settle upon the use of a dynamo which with a current of 10 ampères is capable of producing an E.M.F. of 2,000 volts—a kind of dynamo which was first applied by Mr. Brush, and which is already extensively used for arc lighting, or for a combination of arc lights with groups of glow lamps, several of the latter being always arranged in parallel. But the lamps of which I spoke at greater length in the first part of my paper are made for the passage of the whole current, and will therefore be arranged in series, one being placed in the line after the other. In this case there will be more than 300 lamps on each line; let us say 300. We shall therefore require 20 such dynamos, and one or two spare machines in case of repairs. These 20 dynamos may be driven from shafting, or each by a separate steam engine. There are 20 separate lines proceeding from the central station, and as the main condition of our system is that the current on every line must always be kept constant, we must provide for the regulation of each dynamo in such a manner that the E.M.F. always corresponds to the number of lamps which are in use. This regulation can be effected by automatic devices, or may be done by hand in adjusting the magnetic field or the speed of the dynamo. An ampèremeter which is placed in every circuit will indicate whether this condition is fulfilled, and a voltmeter connected with the terminals of each circuit will inform us how many lamps are used on each line at any time. A registering voltmeter placed in the same manner would be another useful addition. The central station, furthermore, contains a switch-board, which allows any one of the circuits to be connected with any one of the dynamos. If we presume that the station is to supply current day and night, it would certainly be absurd to run all the dynamos constantly at those times, when only a small number of lights are required. At daytime, then, I should propose to loop several circuits together, and if the total number of lamps is sufficiently low, all the 20 circuits might be looped in a single one, so that only one dynamo need be kept running. By means of an auxiliary line of lamps in the central station, dynamos and circuit may be switched in and out without any sudden change in the conditions of either. The system of working would then be that in the afternoon one dynamo after the other is switched into its respective circuit, the requirements of which can always be ascertained on the voltmeter of this circuit. If the consumption of light decreases, the dynamos are gradually switched out again. By the addition of an arrangement for observing and measuring the state of insulation of every line, the outfit of the central station might be considered complete. I have not mentioned any apparatus in connection with the central station which could not be easily constructed with the means at our disposal at the present time.

We now leave the central station, and turn our attention to the conductors. These are 20 pairs of copper wires of small size, say No. 6, well insulated. Experience has shown, so far, that there seems to be no great difficulty in insulating a wire if the tension of the current is not more than 2,000 volts. If we suppose that the central station is in Pimlico, on the banks of the Thames, a few wires may be laid in the direction of Victoria Station, a few more may reach the Houses of Parliament, some may be laid in the direction of South Kensington Museum, and some others may be used for lighting private houses—in each of which I shall suppose that, upon an average, 20 lights are used at the same time. In this case 15 houses are passed by the same conductor, which supplies current for 300 lamps. All these lights can be turned on or off at will, quite independent of each other, because we have provided in the central station that each dynamo is regulated in such a way as always to produce the same strength of current, no matter whether there are 300 lamps alight in each conductor, or only 10.

Let us now compare this system with the only other system in which glow lamps are arranged quite independent of each other, leaving out the consideration of secondary generators. In the parallel system the central station must be in the centre of the district to be lighted, which is often very objectionable, and sometimes impossible. In the series system the station may be far out of the way. In the parallel system we are restricted to the use of a 100-volt lamp, as we have seen before, and, in consequence, the radius of the district to be lighted must be kept very small, or the expenditure for conductors would be prohibitive. In the series system the expense for conductors is comparatively small, and we may reach any distance. The parallel system requires that a fixed difference of potential should be maintained in all the conductors under varying strength of current—a condition with which it is even theoretically impossible to comply, and which entails enormous practical difficulties. In the series system we have to maintain a constant current under varying resistances—a condition which can be easily fulfilled. When the parallel system was first developed, the prevailing idea appears to have been to make electric lighting from central stations similar to gas lighting. But the conditions under which electrical energy in its

active form is best transmitted are so different from those requisite for the transmission of the potential energy of gas, that the desire to imitate the gas system has proved rather a disadvantage.

We now arrive at the last, and perhaps the most difficult, part of the whole installation, viz., the outfit of the place which is to be provided with lamps. For the sake of simplicity, I will suppose the place to consist of one single room, as shown in the sketch.

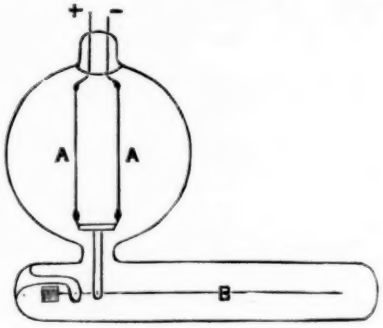

FIG. 3.

In this sketch (fig. 2) the small circles marked L represent lamps; the squares marked S represent switches (which will be presently described); and the cross +, marked V, is to indicate a registering voltmeter. The street main, M, enters the house at the main switch, drawn larger than the others; it continues from switch to switch, and returns to the main switch before leaving the house. We have supposed the street mains to be composed of No. 6 copper wire, but the house mains may be made equal in section to No. 10 wire, in order to be more flexible. The lamps are always connected to their respective switches.

From what has been said before, it is quite evident that the first and essential condition of such a system must be that the circuit is never to be opened, whatever may happen. As we are always dealing with a closed circuit, it will prevent misunderstanding if we give a different designation to the two ways in which the circuit can be completed; and I shall therefore call the circuit "short-closed" if the current goes directly through the switch lever, and "long-closed" if the current is led through the lamps or other electric devices, such as motors, which are to be acted upon. The fact that the circuit is never to be opened reduces one great difficulty in the switch required in the parallel system, viz., the liability to produce an arc.

The main house switch, to which I shall now invite your attention, serves the purpose of either short closing the street circuit, so that no current can pass into the house, or of long closing the same, thus including the house circuit into the main circuit. In the first case I have not considered it sufficient merely to prevent the current from entering into the house; I have thought it advisable to disconnect the house circuit entirely from the street circuit at the same operation, so that any alteration of the circuit may be made inside the house without the possibility of a branch current being established, even if the street circuit should be of defective insulation. But this switch is also made to answer another purpose. Supposing that the street circuit, which has been short closed, is now to be long closed, but that by some accident or another a break of the continuity of the line has occurred in the meantime inside the house: if now the switch lever were to be moved with the intention of allowing the current to enter the house, the result would be the formation of a long arc, and eventually the whole current would be interrupted. The manner in which this has been rendered impossible can be best explained by reference to the annexed sketch (fig. 4), in which A is the switch box, made of insulating material, and L the switch lever, made of conducting material. C, D, and E are three pieces of metal let into the upper edge of the circular box. The lever, L, may occupy three positions, marked 1, 2, and 3. In position 1, C is connected with E, and as C is one terminal of the main circuit and E the other, this circuit is now short closed. But if the lever L is in position 1, it lifts two flat springs of metal, F and G, which are the terminals of the house circuit, from their respective seats on the metal pieces, C and E. The lever, L, carries on its upper side two pieces of insulating material, on which the two springs, F and G, now come to rest, and consequently the house circuit is out of all electrical connection with the main circuit.

If it were now intended to allow the current to pass into the house circuit, the lever, L, would have to be turned from position 1 to position 3; but when the lever passes over the intermediate position 2, it first connects the metal piece D with E. But the metal piece D is permanently connected with C by means of the resistance, R, and the main current will therefore be divided in two parts—one, the greater portion, passing through R and L to E; the other, the smaller portion, passing through the house circuit in case the same is complete. This house circuit includes the electro-magnet, K, which is situated inside the switch, and the armature of this electro-magnet carries a pin, P, which is in such a position that it is below the plane of the motion of the lever L if the armature be attracted, but hinders this motion if the armature be not attracted. In case, then, that the house circuit is complete, there will be no impediment to the further motion of the lever, L, from position 2. It will therefore reach position 3, where it rests upon pieces of insulating material, and the whole current now passes through the house circuit. But if the house circuit had not been completed, the motion of the lever would have been arrested by means of the pin, and a break in the circuit is in this way made a matter of impossibility.

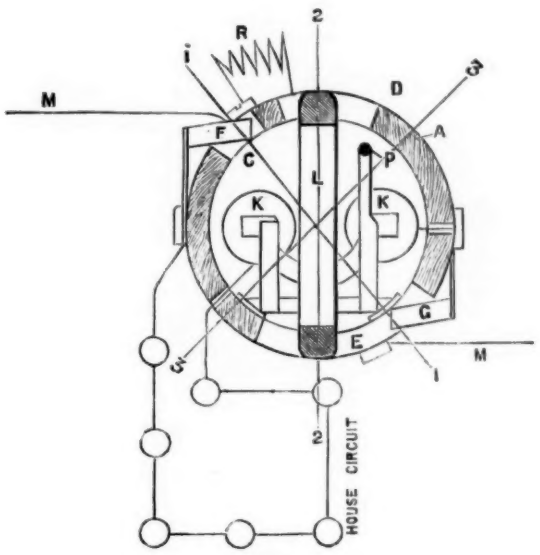

FIG. 4.

I shall pass at once to the lamp switch, because it is practically a mere repetition of the main switch on a smaller scale. But the lamp switch contains an additional arrangement, which would be a useful adjunct to the main switch as well, viz., the automatic cut-out. This is intended to act if the lamp should fail during the passage of the current, in which case the break of the circuit is prevented by short-closing it around the lamp. The arrangements which I have used to provide for this eventuality are of two kinds, and may be shortly described without reference to any drawing. Both are based on the principle that if the resistance of the lamp increases—which always occurs in lamps placed in series when the carbon gives out and an arc is formed—then a current in a shunt around the lamp will increase. In one of these arrangements this increased current is made to act upon the armature of an electro-magnet, which armature releases a spring for the purpose of making a direct secure contact between two places of the circuit in which the lamp is situated, and a short circuit is thereby formed round the lamp. In the other arrangement a fusible wire is placed in the shunt, and a lever is arranged in such a way as to be acted upon in one direction by the wire, and in the other by a strong spring. If the wire fuses, the spring presses the lever against contact pieces, which serve the same purpose as specified above. In neither case can the circuit, which is now short-closed, be made to include the lamp again until the cut-out lever has been moved into its former position by hand. The combination between the switch and the cut-out lever is such that the switch-lever has to be placed into position 1, before the cut-out lever can be operated upon by hand. The reason for the adoption of this last arrangement will become evident by a consideration of the peculiarities of the switch which I have mentioned before. I believe that in this way I have provided for the prevention of a break in the circuit which may occur from any eventuality.

I need not dwell on the construction of the lamp-holder, the only part of the outfit which has not yet been mentioned. It may be made in different ways, but one principal idea has been adhered to in its design, as well as in that of all other details which constitute the outfit of a house; there is no part conveying a current which is not perfectly insulated, or which is in any way exposed so as to offer the possibility of any person coming into contact with it. This is hardly possible in arc light circuits, but may easily be done where only glow lamps are used.

And this brings me to the last question which I shall have to consider, namely, the question of safety. Here again I shall have to note one very great advantage of the series system over the parallel system, and this is the impossibility of a wire becoming overheated. Every experienced electrician knows as a fact that short circuits in the parallel system have often led to detrimental results in spite of safety fuses; and a system in which such a danger does not exist, and which consequently does not require any provisions against it, has certainly much to recommend it. Especially in such cases in which the danger of fire must be most dreaded—in ship lighting—I believe that this advantage of the series system will be very greatly appreciated.

I now come to the objection generally raised against the use of

high tension currents. If an inventor were to appear to-day saying he wanted to introduce into our houses a substance which, when properly used, was intended to give light, but which in itself was a poison, and produced poisons when used as a light, and of which it was further known that it was always ready to form an explosive agent when mixed with atmospheric air, I believe that the critical spirit of our time would raise an outcry against the introduction of such a dangerous substance, and against the use of the public streets for its conveyance. But this substance—of which we know that it is quite harmless as long as it is retained within metal tubes—is now actually carried into all our houses, and we are so familiar with its peculiarities that no one feels any nervousness nowadays in the neighbourhood of a gas chandelier.

In conveying a high-tension current into a house we are in a far more favourable position than if dealing with gas, because the probability of an accident is far more remote. Three conditions must be fulfilled before any person can be injured by an electric current. First, there must be a certain amount of leakage on the line; secondly, the person must be in contact with a bare conductor; and, thirdly, the person must at the same time be in contact with the ground.

In the system of central lighting which I have laid before you it is easy enough to constantly ascertain the condition of the line, and far easier to locate a fault than in a complicated system of branch wires. It is, further, easy to construct all parts of the system inside a house in such a manner that contact with a bare conductor is impossible; and, moreover, a person standing on a carpet and a dry wooden floor is exceedingly well insulated. The tension which we can use with safety depends simply upon our means of insulation. If you will recall the precautions which have been taken in the construction of the switches by entirely disconnecting parts of the circuit from the main circuit, when lamps have to be replaced or alterations to be made in the circuit, then I think you will agree with me that the probability of an accident is exceedingly remote; and this system of lighting appears to offer more safety than any other method of artificial lighting at present in use.

And now, in conclusion, I should like to say that in a short paper like this which I have had the honour of reading to you, I found it impossible to enter more fully into details than I have done, and I have therefore restricted myself to the explanation of those details and the discussion of those questions which appear to me of prominent importance. I hope that by my humble efforts I may have accomplished the object of my labours, namely, the further extension of the field of electric lighting.

In the discussion which followed the reading of Mr. Bernstein's paper,

Mr. PREECE said none but those who have actually had the electric light fitted in their houses can possibly have any idea of the great advantage and comfort of the method of illumination. The introduction of the electric light into dwelling houses he contended would do more good than any of the arrangements suggested by sanitary institutes. He objected to the use of the word "strain" as applied to the number of watts per candle at which a lamp was worked, especially as the term was very ambiguous in its meaning. Mr. Bernstein had laid great stress upon the fact that high resistance filaments are very well in their way, but that they are very expensive. What we want is cheap forms of lamps worked at a high power for a moderate period—say, 200 hours; such lamps would probably be the most economical in the end. A great point about the series system of working lamps was the non-liability to short circuiting. This short circuiting was a most serious matter in the case of the parallel system. He had come to the conclusion that there were as many dangers in electric as in ordinary methods of lighting unless proper care was exercised in putting up the installation. The result of a main breaking down in the series system was a point which must not be overlooked. He considered Mr. Bernstein's paper was one of great interest.

Mr. RAWSON said that with reference to the construction of incandescence lamps, they had to rely to a great extent upon secrecy in the matter, and he could not therefore say much as to his own experience. He would ask how joints would be made in a series system in which the current had continually to be kept on, as it must be in some installations. He thought it a pity that the use of accumulators had not been mentioned. The question of the occluded gas in the mounts of the filaments was, he thought, a difficulty which had to be got over. Did the lamps alter in resistance from use? He thought that safety junctions ought to be placed at every lamp, and not at every room only, as advocated by Mr. Preece in his paper before the Society of Arts. With reference to the "flaming" mentioned in the earlier part of the paper, he thought that this was due to the vacuum being imperfect. The temperature at which the lamp was burnt was he considered too high for durability. The question of short circuits from leakage in the series system, due to accumulation of moisture, was, he believed, a much more serious difficulty than might generally be imagined.

Mr. R. E. CROMPTON pointed out that Mr. Swan, when he first took up the manufacture of incandescence lamps, had intended to work on the same lines as Mr. Bernstein had; but he (Mr. Crompton) had dissuaded him from doing so. He thought the difficulties in connection with the series method of working were enormous; if double earth faults occurred, the system will be very dangerous—indeed, he doubted whether the Board of Trade would sanction the use of the high potential necessary for the system. Short circuits through the body took place often in a most unexpected way. He differed from Mr. Bernstein as regards the high efficiency of lamps; he considered 50 and 110 volt lamps to be equally good. A good Swan lamp should last 2,000 hours at full candle-power. The double mount required in the Bernstein lamp presented a difficulty, as it did not admit of so elegant and neat a suspension as in the case of the ordinary lamps. The constant current question, which was a vital one in the case of the series system, was one of extreme difficulty; the constancy had been attempted to be effected by means of an electrical governor, but not with perfect success, as a change in the number of lamps in the circuit produced a perceptible effect upon the others. It was far easier to keep the potential than the current constant. He thought the author's reference to occluded "oxygen" in the filament mounts to be a mistake, as he had heard of occluded hydrogen but not of occluded oxygen; the phenomena observed must therefore be due to some other cause than that suggested. The jumping across which was stated to take place in lamps when others were switched off was a phenomenon which never took place now that lamps were properly made. In conclusion, he expressed his opinion that the light from the large filament was in no respect superior to that from the ordinary fine filament.

Mr. MORTIMER EVANS explained that the economy of the light from an incandescence lamp greatly depended upon the radiation from the bright surface, and this depended upon the nature of the carbon. He thought that an economy of 2 watts per candle ought to be obtained. A point to be remembered was that with large lamps the electromotive force might be as high as we pleased; the difficulty was to get small lamps with a high electromotive force. Any improvement in brightening lamps must be in the direction of lowering their electromotive force; it was not advisable to raise the temperature.

Mr. DRAKE agreed with Mr. Crompton as to the difficulty of keeping a constant current; he knew of no regulator which would effect the desired result properly, because it was necessary that a change should take place before the regulation could be effected. He thought that safety appliances absorbed too much power. Resistances were, he considered, very liable to derangement.

Prof. FORBES thought that the shunt difficulty had been solved by Mr. Bernstein, but the expense of the arrangement was, he considered, rather a serious matter, the great saving which would result in the conductors might, however, more than counterbalance this. If it could be proved that the lamps were durable there were many cases in which the series system would be used with great advantage. As regards the constant current difficulty, quite irrespective of compound winding, he would point out that in America the principle had been carried out to a great state of perfection; this was especially the case in the Thomson-Houston system. Weston also had been successful in the matter. One great advantage of the series arrangement was its safety; he affirmed this in spite of what Mr. Crompton and others had said on the subject. No short circuiting could occur as in the parallel system. Earth faults could be avoided by constant testing and cutting off the houses in which earth faults were found; the locality of a fault could be much easier traced in a series than in a parallel system.

Sir DAVID SALOMONS found that the 50-volt lamps became blacker much sooner than did the 100-volt lamps, a result due to the fact that the area of the glass was smaller in one case than the other. No arcing should take place if the vacuum were good. He had run his installation for 2½ years without any arcing taking place. He employed the parallel system, and it had given no trouble whatever. He thought that there was a considerable amount of power lost outside the filament itself. Switches ought to be made of china or some other incombustible material.

Prof. AYRTON said that the cost of renewals of lamps was an insignificant item in the total annual expenses, taking the cost of the lamps at 5s. per 1,000 hours. The danger question was much exaggerated; a potential of 2,000 volts would not necessarily kill anyone provided the current were continuous, the danger was from want of continuity; the use of a great number of commutator bars and symmetry of make would avoid this. The constancy of the current in the Thomson-Houston system was obtained by a regulator which moved the brushes. He was inclined to think absolute constancy of potential was the most difficult to obtain. A great point in the low resistance lamp was that in the case of temporary installations a few cells (though possibly of large dimensions) only would be required, the electromotive force required being low. With reference to the use of the word "strain," he thought that "efficiency" much more exactly expressed what was meant.

Prof. SILVANUS THOMPSON considered that a constant current system avoided many difficulties, that of self-induction for instance. It was a curious fact in the Thomson-Houston system that the lamps became perfectly regulated when a number of others were cut out of circuit before the brushes had taken up their final position. The statement that a low resistance lamp was less economical than a high resistance one was, he thought, absurd, as a large hollow filament was nothing more than a bundle of thin filaments joined up in parallel arc.

Col. WEBBER asked how the platinum of the Bernstein lamp was secured to the glass, and also what was the quality of the latter.

Mr. R. E. CROMPTON drew attention to a point which appeared to have been overlooked in the question of constant current regulation, and that was, that in the Thomson-Houston system arc lamps were used, which were in themselves regulators.

The discussion was then adjourned.

NEW PATENTS—1886.

4118. "Incandescent electric lamps." C. Seel. Dated March 24.

4130. "Counting and recording the number of messages transmitted over telephonic circuits." J. D. Miller. Dated March 24.

4132. "Dynamo-electric machines." M. Bohdanecky, J. Nesetril. Dated March 24.

4133. "Electric arc lamps." H. Pieper. Dated March 24. (*Complete.*)

4147. "Utilising electric bells for telephonic purposes." E. Tuteur. Dated March 24.

4162. "Construction and arrangement of electrical conductors mainly applicable to telephonic purposes." W. Christiani. Dated March 24.

4195. "Soles and heels of boots and shoes, with and without galvanic arrangement, and of socks for same with galvanic arrangement." J. B. Walker, J. Horrocks. Dated March 25.

4214. "Electric baths." C. Wells. Dated March 25.

4230. "Telegraphs." A. M. Rosebrugh. Dated March 25.

4231. "Telephones." A. M. Rosebrugh. Dated August 15, 1885.

4232. "Telegraphs." J. Y. Johnson. (Communicated by A. M. Rosebrugh.) Dated March 25.

4275. "'Morse' or dot and dash printing telegraphs." H. A. C. Saunders, A. C. Brown. Dated March 26.

4276. "Fire alarm telegraphs." H. A. C. Saunders, A. C. Brown. Dated March 26.

4280. "Electro-magnetic apparatus to be used for curative and remedial purposes." J. R. Chislett. Dated March 26.

4308. "Dental engines operated by electricity." A. Kirby. Dated March 27.

4324. "Electric lighting." R. C. Hanrott. Dated March 27.

4352. "Voltaic batteries." T. J. Jones. Dated March 27.

4401. "Telephones." E. Edwards. (Communicated by E. A. J. Rosoor.) Dated March 29.

4407. "Electric arc lamps." F. Thornton. Dated March 29.

4412. "Junction or testing boxes for electrical conductors." J. G. Lorrain. Dated March 29.

4431. "Covered or insulated wires." A. J. Boult. (Communicated by W. M. Habershaw.) Dated March 30. (*Complete.*)

4453. "Electrical cells or batteries." M. Bailey, J. Warner. Dated March 30.

4454. "Arrangement of portable electric light." W. E. Moser. Dated March 30.

4459. "Constructing incandescent or glow lamps with many filaments in each." R. C. Hanrott. Dated March 30.

CORRESPONDENCE.

Secondary Batteries as Regulators.

With reference to the letter of Sir David Salomons to your journal last week, and the results obtained at Mr. Littleton's installation relative to the question of the conditions under which secondary batteries act most efficiently as regulators, the following explanation has appeared to me the most rational one.

The main reason why secondary batteries act as regulators at all when charged by a shunt machine is, that they tend to maintain a constant strength of field in the dynamo; and with a field maintained constant in this manner, the variation of E.M.F. of the dynamo is only directly proportional to the variation in speed; while in a well constructed shunt machine where the field-magnets depend for their excitation upon both the armature and a varying resistance in the outside circuit, the E.M.F. varies in a more rapid ratio with changes in speed.

Now, so long as current from the dynamo is distributing itself between the secondary batteries and the external circuit, it is obvious that no current can be passing out from the cells; and thus the field of the dynamo is dependent for its strength on a variable resistance, or back E.M.F. of the cells; consequently, the variations in E.M.F. are marked, and pulsations in the light occur.

If, on the other hand, the cells are receiving no current, which means that their resistance (and back E.M.F.) exactly balances the mean E.M.F. of the machine, practically perfect regulation ensues, since they compensate for any shortcomings in the E.M.F. of the dynamo.

As an illustration of the truth of this, anyone who has worked with secondary batteries will recall to mind that a marked pulsation has generally occurred, due to the gas engine, on a given outside circuit if the state of the charge of the cells is low; but as the cells get charged, and their E.M.F. balances that of the dynamo, the pulsations under the same external conditions will cease.

I have seen this change from pulsation to perfect steadiness occur in an instant of time; showing how delicate must be the required balance.

And this brings me to another point that seems to have escaped general notice.

It is not uncommon to find installations put down where accumulators and dynamo have to share between them the outside work; that is, it is hoped that the dynamo and accumulators—each of which are to contribute, say, one-half of the electrical energy required—will obligingly contribute their share without trying to shirk some of it on to the other; whereas the dynamo will not cease to do the whole of the work until such time as the E.M.F. of the cells from one cause or another balances that of the dynamo. Thus the dynamo is generally overworked, unless hand regulation be provided.

This means that we must be content to use secondary batteries simply as regulators, and not attempt to charge them systematically when the outside circuit is switched on, if the conditions of working are with an intermittent speed. Under the above conditions of working, the regulation, *i.e.*, freedom from pulsation and equality of brilliancy under varying loads, will not be affected whether the number of lamps in use is small or large, as Sir David Salomons suggests.

I cannot coincide in the opinion put forward on page 247 that "the proper condition of things required for charging accumulators when the power is supplied by a gas engine or by any prime mover where the delivery of power is in the nature of emphasised intermittent pulsations" is where "the difference of potential falls considerably as the current increases."

It implies a condition of things which in constructing a shunt machine generally is to be avoided; and even in the special case of use in conjunction with secondary batteries it seems to me to mean that if the dynamo is in operation at the same time as the cells on the external circuit, regulation becomes practically impossible.

R. Percy Sellon.

Belvedere Road, S.E.,
March 25th, 1886.

The Bassano Case Digested.

As Mr. Justice North's judgment in the Bassano Telephone Case is very long, I have taken the liberty of extracting therefrom the plums, which I give, as a plain man, in plain language.

(1). The mechanical telephone or lovers' telegraph is as old as the hills; but although some methods of transmitting music by electricity were known, there was no mode known of transmitting articulate speech before Edison's patent of July, 1878. [Edison, therefore, not Reis, nor Gray, nor Bell, is the real original inventor of the speaking telephone.]

(2). This being so, he must be held to have discovered a very remarkable new manufacture and deserves to have his patent stretched beyond its plain meaning.

(3). He has disclaimed everything except the combination of something which he calls a diaphragm or tympan with something else which he calls an electric tension regulator.

(4). He said, it is true, that his diaphragm or tympan must be like a drum, of vellum, metal, horn, or mica; but he also said that there might be one or more diaphragms or tympans at the ends or sides of the instrument, and that they might be of different shapes and

sizes. Therefore everything that anyone places at the ends or sides of an instrument, whether flexible like mica or not, whether like a drum or not, is a diaphragm or tympan, provided it is of a different size or shape from the drawings.

(5). When you speak to a thin diaphragm it vibrates. When you speak to a thin tube it vibrates. Sir Frederick Bramwell's experiments conclusively prove this. It must not be thought that this proves that the tube was thin. On the contrary, it proves that a tube is a diaphragm or tympan.

(6). Although Edison never said a word about difference of air pressure at the two sides of a diaphragm, everything is a diaphragm when there is a difference of air pressure between the two sides of it. [Everything—from a stick of sealing wax to the solid earth itself.]

(7). The defendants were usually successful with their experiments, the plaintiffs usually unsuccessful. This points to the possibility of further discoveries in the science of experimenting. Nevertheless, judgment is for the plaintiffs.

(8). In some of Edison's tension regulators no carbon is used at all—only soft metals, silk fibre, or platinum; so [although Edison never mentions "carbon" at all] he is entitled to the exclusive use of carbon as a tension regulator.

(9). A billiard ball of ivory when dropped from a height is compressed to half its diameter.

(10). This proves the billiard ball to be elastic and compressible, and therefore, because hard carbon balls will also bounce, this proves them to belong to the same category as silk fibre coated with plumbago, soft metals, mixtures of plumbago with gum rubber, and lamp black.

(11). For Edison to call carbon a semi-conductor is [in spite of the fact that he never used the word carbon and therefore didn't "call" it anything] a fair description. [Note the judicial ideas as to fairness.]

(12). Sir W. Thomson swore that he had seen many forms of Edison's instruments as described in the specification [Query, the silk fibre, or the platinum tubes—or which?] in practical use, and as defendants' counsel did not cross-examine him on this point, this proves the things described in the specification to be useful forms of instrument.

(13). Because Bassano uses the same kind of hard carbon pencil as are used by Blake, Gower-Bell, Ader and Theiler [all of whom derived them from Hughes's microphone], therefore he is using the substance discovered by Edison to be the best.

I would ask your readers kindly to verify for themselves in the corresponding portions of the judgment of the learned judge the essential accuracy of these dozen plums.

l'Homme Qui Rit.

P.S.—I see that the *Times* reporter has judiciously omitted some of the above plums.—l'H. Q. R.

Secondary Battery Indicators.

No reply having appeared to Mr. Elwell's letter on the above subject in your issue of the 19th March, I venture to say with reference to the suggested difficulty of maintaining the electrolyte at a constant level is not a very difficult matter to ensure within practical limits on the part of the attendant by the ordinary means of filling up the cells with water to the proper mark as it evaporates; but if it is desired to effect it with exactitude automatically, a simple method which I know to have been adopted by Mr. Sellon is to use an inverted flask or vessel which, as occasion requires, is refilled with water and placed with its neck or outlet tube at the level which should be maintained. Displacement, of course, takes place, and compensates for the loss by evaporation or other cause. One of the main objects of employing indicators is to prolong the life of the plates by ensuring proper limits of charge and discharge; it may be well, therefore, to consider the action of the apparatus described by Mr. Elwell relatively with Mr. Sellon's arrangement, described in your edition of March 12th.

In the first case, viz., Mr. Parker's device, which he states is not affected by alteration in the level of the electrolyte. By evaporation of the water the solution becomes higher in density, and, as a result, his apparatus cuts the cells out of the charging circuit before *they are fully charged*, also allowing them to remain in circuit until *they are over-discharged*.

In the second case, supposing no compensation is made as arranged for by Mr. Sellon, the increased density through evaporation, &c., would cause the apparatus to bring the cells into the charging circuit *before they were fully discharged*, also allowing them to remain in circuit until *they were slightly overcharged*, certainly the preferable alternative for keeping the cells in good working order; but, as I have already said, the maintenance of a constant level presents no difficulty, and no such variations need occur.

Henry A. Kent.

March 29th, 1886.

Electric v. Oil Lamps.

From your editorial comments on my letter of the 23rd inst., appearing on page 291 of your issue of the 26th inst., you do not, I fear, grasp my meaning as my remarks will apply in a general sense, whether it be a single lamp purchased or a certain portion of current rented by a consumer.

It is obvious that however cheap electric light may be, it yet costs money, and if it were given *free* to anyone its cost (?) would be then *only one* times less than oil or gas. If, therefore, oil, say, costs £5 for a given period, and electric light *one-and-half* times less, viz., £7 10s. less, it is plain that the balance of £2 10s. is on the other side; or, as I said, the electric light companies or firms would need to pay the purchaser (?) or consumer £2 10s. for taking the electric light. Therefore, if E.L. is to cost one-and-half times less than oil, the apparatus, in whatever form, must be produced for *something less than nothing*. Surely, I imagine I was right when I said that I feared it was a misprint; perhaps *one-and-half* meant *one-half?* If there is another way of elucidating what to me is a mystery I should be happy to hear it.

Arthur E. Cotterell.

Birmingham, *March 29th*, 1886.

The Electric Lamps in the Law Courts.

I enclose a cutting from the *Daily Chronicle* of the 30th inst., which I doubt not has come under your notice. In my humble opinion, when the reporter of an influential paper like the *Chronicle* commits himself to the statement that the electrical engineer of an important installation like the Law Courts informs a judge on the bench that "*a screw passing through the top of the glass*" of an incandescent lamp is "*too fine*" (or too coarse), either the electrical engineer who makes such a statement, or the reporter who reports that such a statement was made, is somewhat short of common sense. Taking it for granted that a man appointed to the post of electrical engineer at the Law Courts knows something about his business, I cannot think he ever made such a statement, consequently, if that is true, either the hearing or intelligence of the reporter must be at fault.

What I would suggest is that our non-scientific papers should, before they launch on the public ear statements of this or any other technical kind, first convince themselves by expert evidence that there is at any rate a possibility of their report being within the range of practical demonstration.

Fair Play.

London, *March 31st*, 1886.

P.S.—If the correspondent of the D. C. is so far at sea in regard to the lighting, what about his accuracy in regard to the rheumatism, bronchitis, catarrh, &c.?